A380
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSE - T1 & T2 (RR / Metric)
LEVEL I - ATA 70 Power Plant (RR)

This document must be used for training purposes only

Under no circumstances should this document be used as a reference

It will not be updated.

LEVEL I - ATA 70 POWER PLANT (RR)

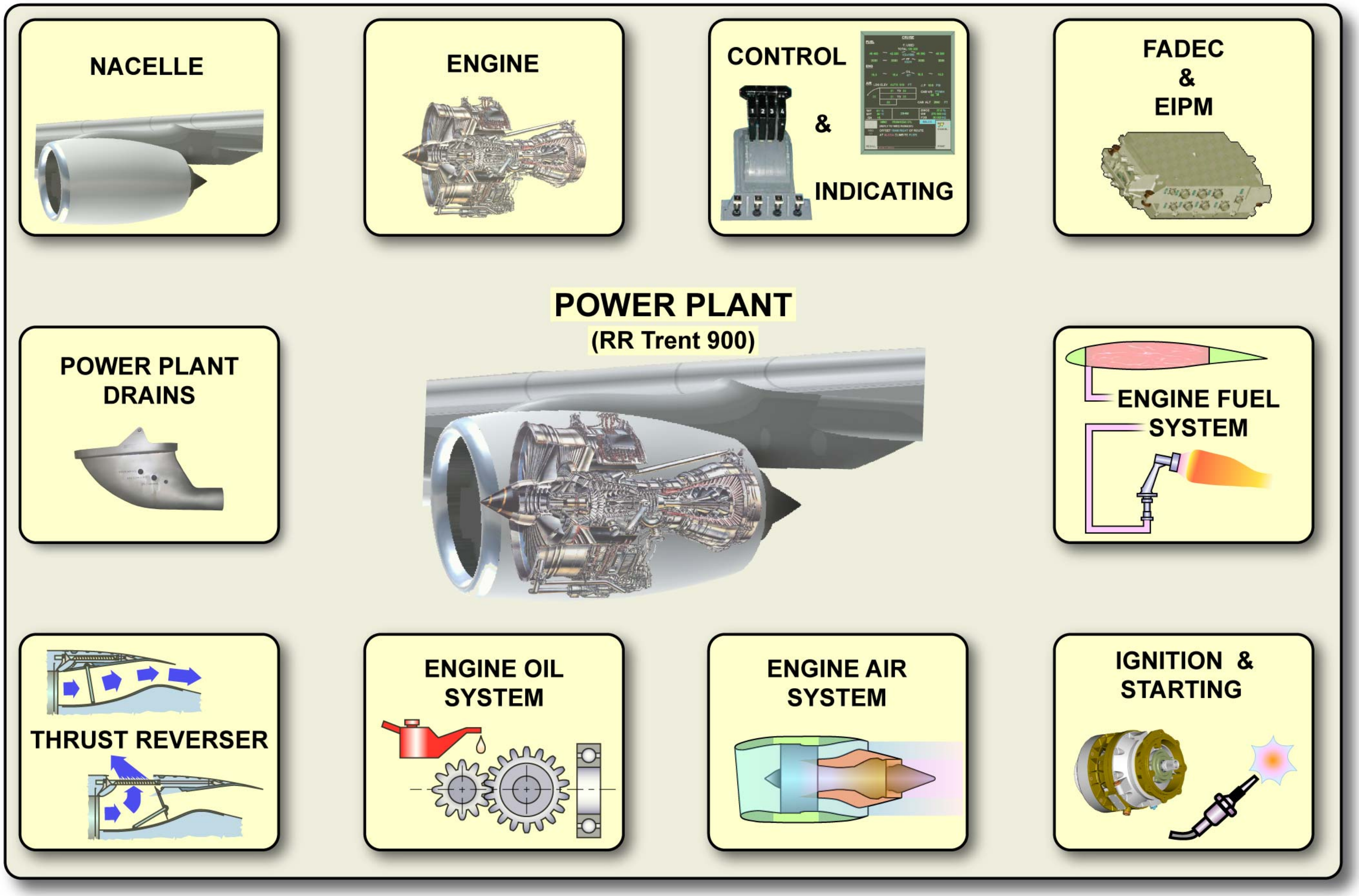
L1W06161 - L0KT0T0

POWER PLANT INTRODUCTION (1)

General

The primary function of the power plant is to supply propulsion power to the aircraft.
The secondary function is to supply:
- electrical power,
- pneumatic power and,
- hydraulic power.

The Power Plant is made of:
- nacelle,
- engine,
- related control and indicating,
- Full Authority Digital Engine Control (FADEC) and Engine Interface and Power Management (EIPM),
- engine fuel system,
- ignition and starting,
- engine air system,
- engine oil system,
- thrust reverser and,
- power plant drains.


NACELLE
ENGINE
CONTROL
&
INDICATING
FADEC
&
EIPM
POWER PLANT
(RR Trent 900)
POWER PLANT
DRAINS
ENGINE FUEL
SYSTEM
THRUST REVERSER
ENGINE OIL
SYSTEM
ENGINE AIR
SYSTEM
IGNITION &
STARTING

GENERAL

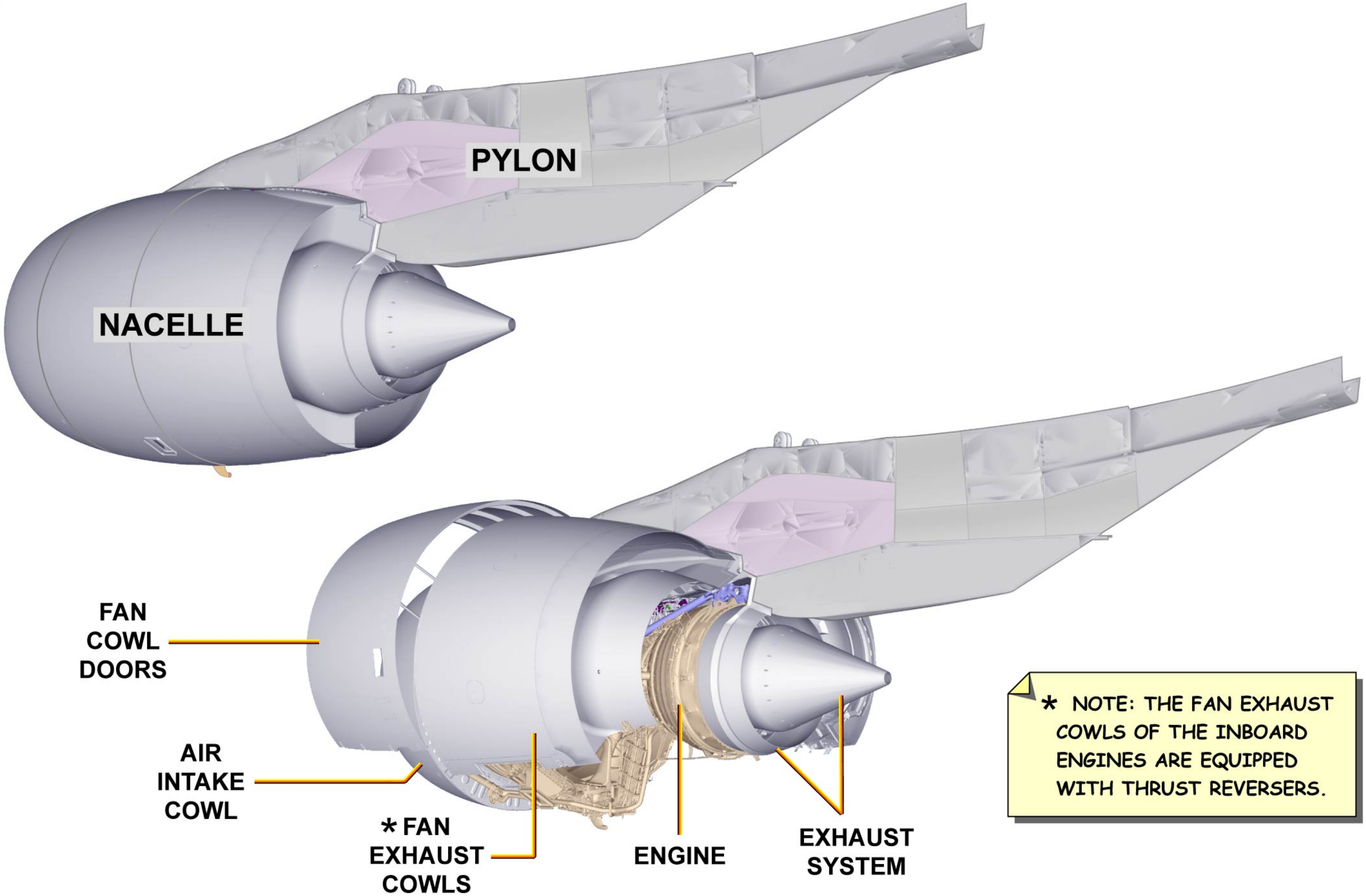
NACELLE PRESENTATION (1)

General

The Pylon fulfils all interfaces between the aircraft wing and the power plant (engine plus nacelle assembly).
The Nacelle provides a smooth airflow around the engine and its accessories.
It also provides:
- Engine protection,
- Engine ventilation,
- Noise attenuation,
- Thrust reverse (inboard engines only).

The nacelle includes:
- an air intake cowl,
- 2 fan cowl doors,
- 2 fan exhaust cowls,
- an exhaust system.

The nacelle gives access to the engine components.
Note: The engines are numbered from 1 to 4 from the left to the right.

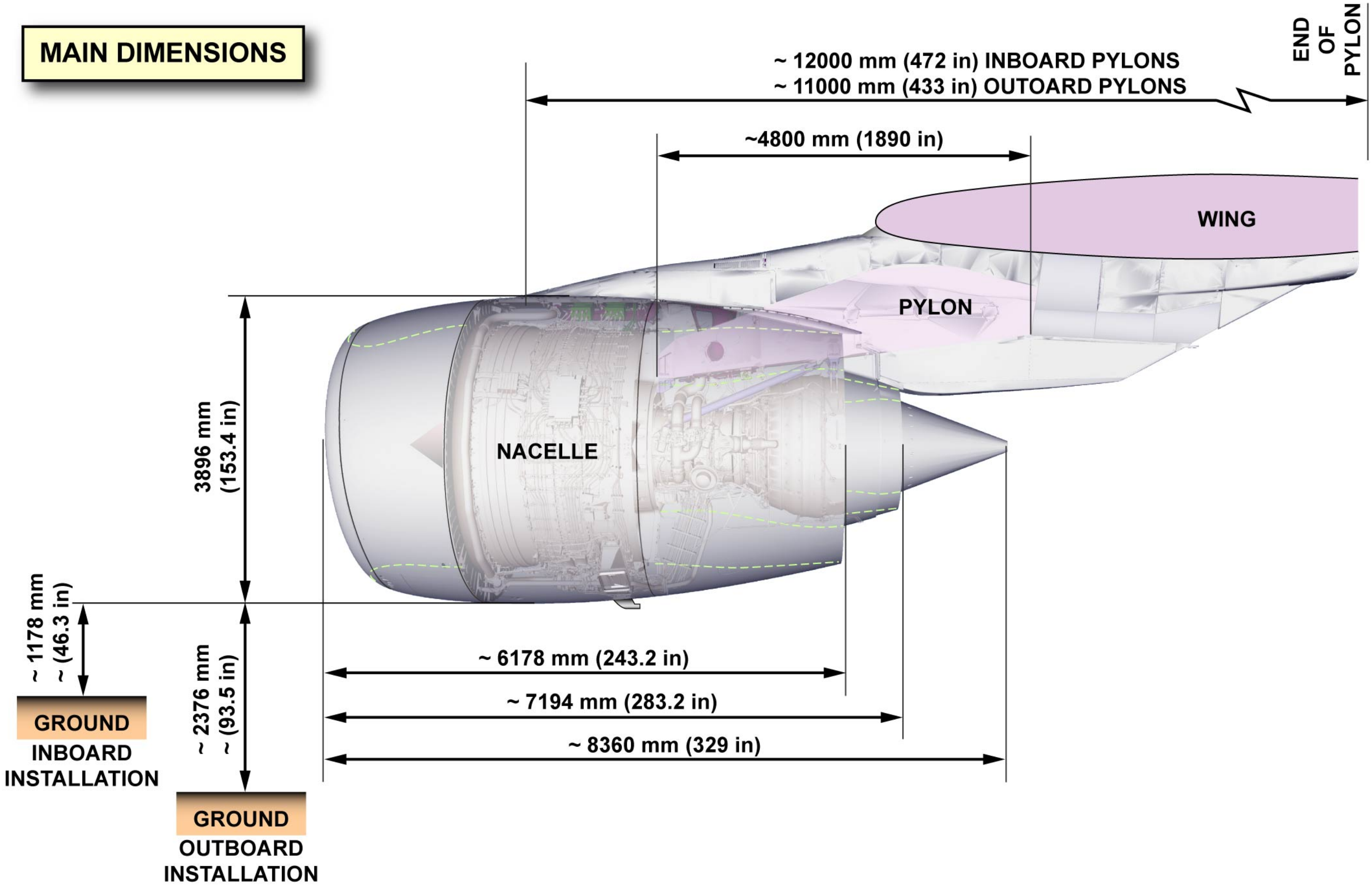

PYLON
NACELLE
FAN
COWL
DOORS
AIR
INTAKE
COWL
* FAN
EXHAUST
COWLS
ENGINE
EXHAUST
SYSTEM
* NOTE: THE FAN EXHAUST
COWLS OF THE INBOARD
ENGINES ARE EQUIPPED
WITH THRUST REVERSERS.

GENERAL

NACELLE PRESENTATION (1)

Main Dimensions

The total length of an inboard pylon is about 12 meters (472 inches) and about 11 meters (433 inches) for an outboard pylon.
The total length of the nacelle is about 8,360 meters (329 inches).
The maximum diameter of the nacelle is about 3.9 meters (46 inches).



MAIN DIMENSIONS

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NACELLE PRESENTATION (1)

Pylon

The pylon is made of a primary structure and a secondary structure.
The primary structure (also called pylon box) carries the mechanical loads between the power plant and the aircraft wing.
The secondary structure has fairings and space for components.
The secondary structure is composed of a front secondary structure (also called cantilever) and a rear secondary structure.
The pylon also includes an aft pylon fairing (also called lower fairing) and karmans that gives access to the pylon to wing mounts.

Interfaces: Pylon / Power Plant

The pylon interfaces with the power plant through engine mounts, connections and cowling fittings.
The installation is designed to make the engine change easier.

Engine Mounts

The Engine Mounts transfer power plant loads to the pylon.
There are 3 mount assemblies between the engine and the pylon: the forward mount, the aft mount and the struts mounts.

FORWARD MOUNT ASSEMBLY

The Forward Mount assembly carries most of vertical and side loads.
It is attached at the intermediate case of the engine.

AFT MOUNT ASSEMBLY

The Aft Mount assembly carries vertical, side and torsion loads.
It is attached to the tail support structure of the engine.

STRUT MOUNTS ASSEMBLY

There are 2 Strut Mount assemblies, which transmit the engine thrust.
The right and left strut mounts are attached on each side of the intermediate case of the engine.

Connections

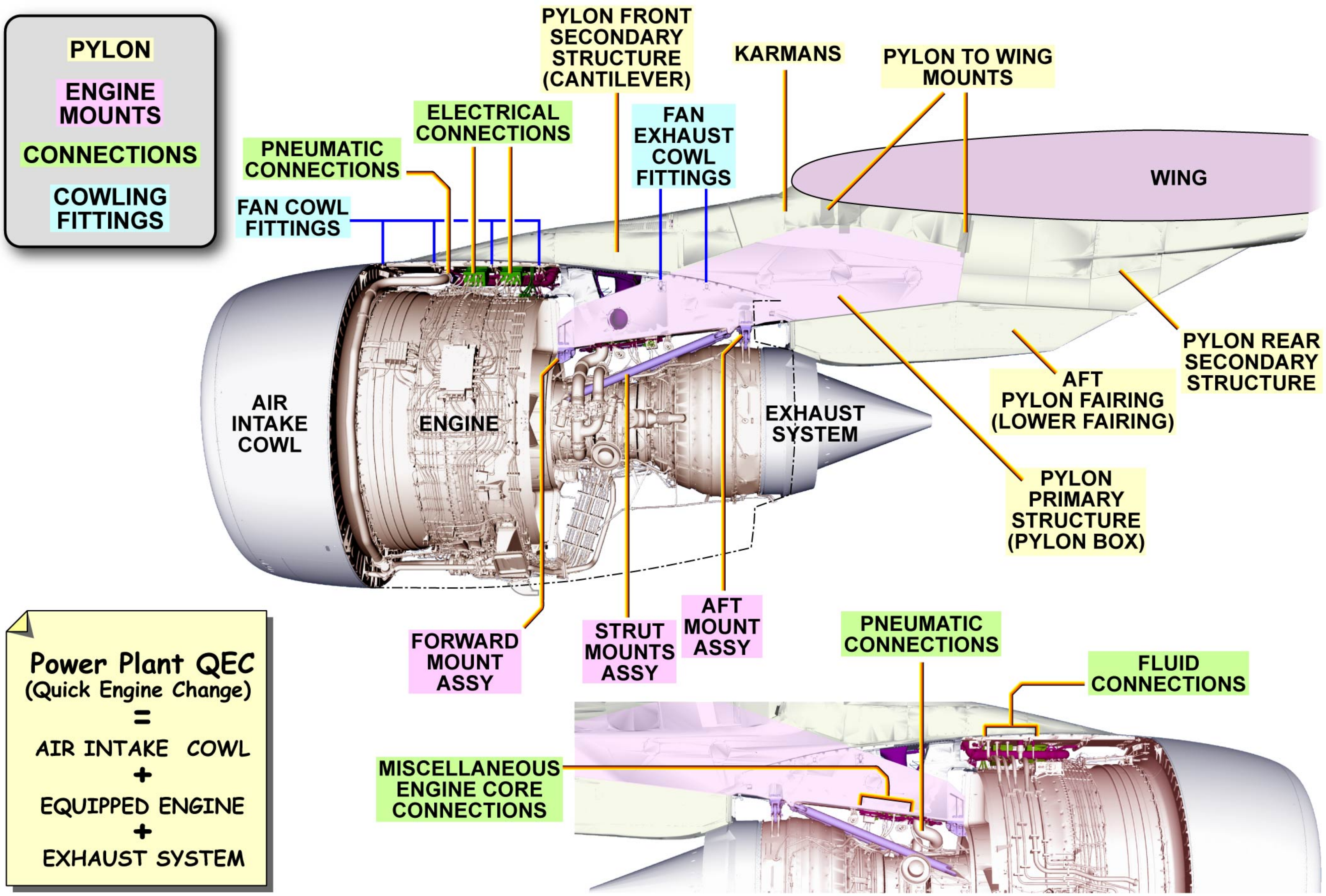
On the left hand side of the pylon front secondary structure, there are pneumatic (starter) and electrical connections.
On the right hand side of the front secondary structure, there are fluid connections (fuel, hydraulics).
Below the pylon primary structure there are pneumatic connections (bleed air) and miscellaneous connections (fire protection, hydraulic tank pressurization, pylon drains, etc).

Cowling Fittings

The fan cowls are attached to the pylon front secondary structure whereas the fan exhaust cowls are attached to the pylon primary structure

Quick Engine Change (QEC)

A Quick Engine Change (QEC) unit is an engine, which is prepared and ready for installation on the pylon.
A QEC includes:
-The air intake cowl,
-The engine,
-The exhaust system,
-The applicable accessories.
Note that a QEC does not include the fan cowl doors and the fan exhaust cowls because they are directly installed on the pylon and they remain on it in case of quick engine change operation.



PYLON & INTERFACES: PYLON / POWER PLANT

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NACELLE PRESENTATION (1)

Nacelle Components

The nacelle has the following components:

Air Intake Cowl

The air intake cowl collects and ducts the airflow to the engine fan and core.
It is attached on the front part of the engine by flange.
Acoustic materials are used to decrease the engine noise.
The air intake cowl is anti iced

Fan Cowls

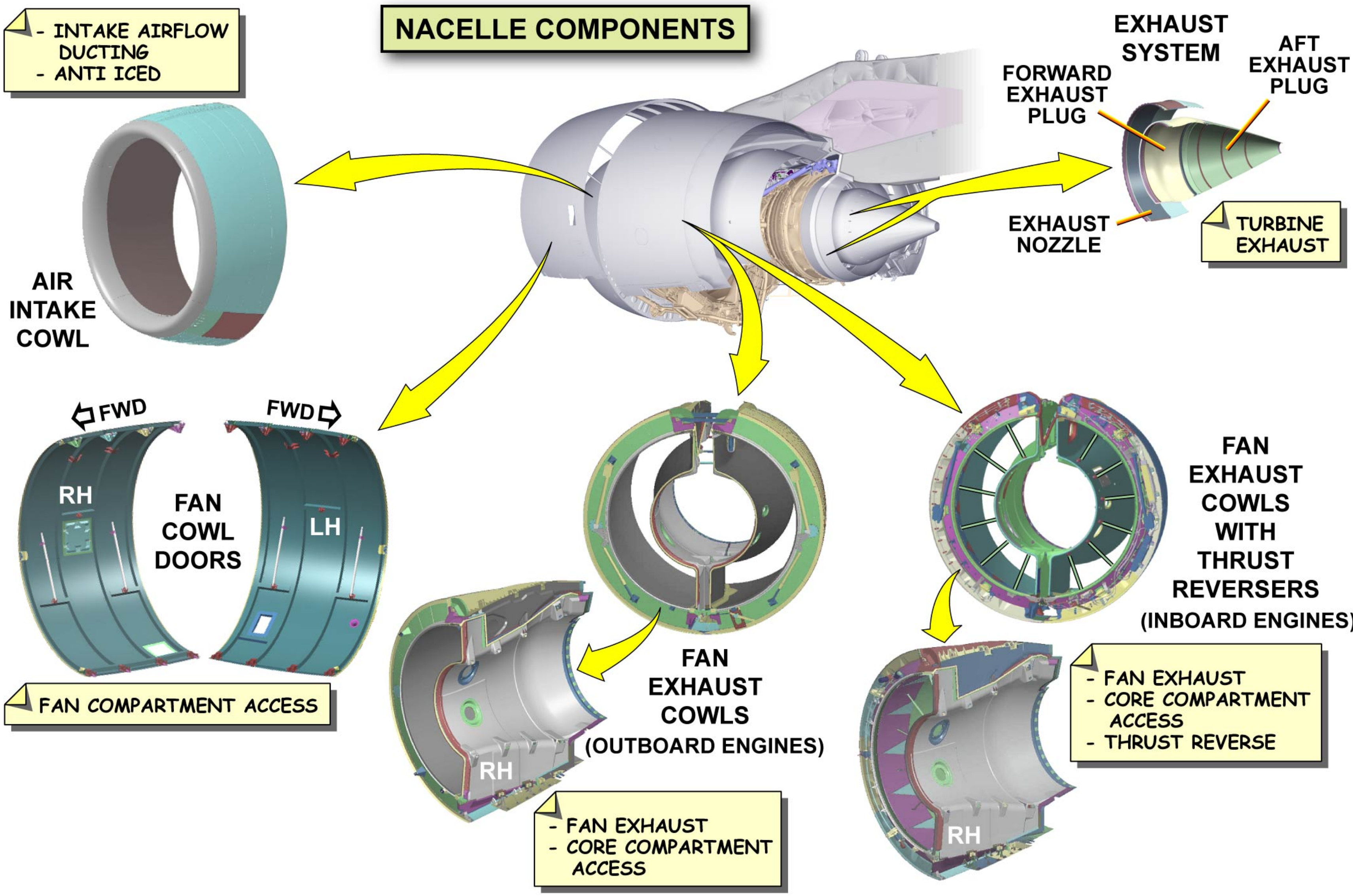
The fan cowl doors give access to the fan case mounted accessories.
The fan cowls are electrically open. When opened they are held in position by hold open rods, they are latched at their bottom center line.

Fan Exhaust Cowls

The fan exhaust cowls duct fan airflow around the engine core and act as a nozzle.
They have 2 symmetrical ducts wit a "C" shaped cross section.
Acoustic materials are used to decrease the engine noise.
The fan exhaust cowl doors give access to the engine core mounted accessories.
The fan exhaust cowls are electrically open. When opened they are held in position by hold open rods and are latched at their bottom center line.
Note that the Fan Exhaust Cowls on the inboard engines have thrust reversers.

Exhaust System

The exhaust system directs rearward the hot exhaust gases from the turbines.
It is composed of the exhaust nozzle and the exhaust plug.
They are attached to the rear part of the engine by flanges.
Note that the exhaust plug is composed of 2 parts: the forward exhaust plug and the aft exhaust plug.
Acoustic materials are used to decrease the engine noise.



NACELLE COMPONENTS - AIR INTAKE COWL ... EXHAUST SYSTEM

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NACELLE PRESENTATION (1)

Maintenance Access

For complete access to the engine mounted components, it is necessary to open the fan cowl doors and the fan exhaust cowls, for this function, there are latches installed at the bottom center line of the nacelle.
However for quick servicing the nacelle has inspection and access panels.
The drain mast is also installed at the bottom center line of the nacelle.

Nacelle Left Side Access

On the left hand side of the air intake cowl there are:
- the left fan cowl up/down switches and,
- a maintenance interphone jack.

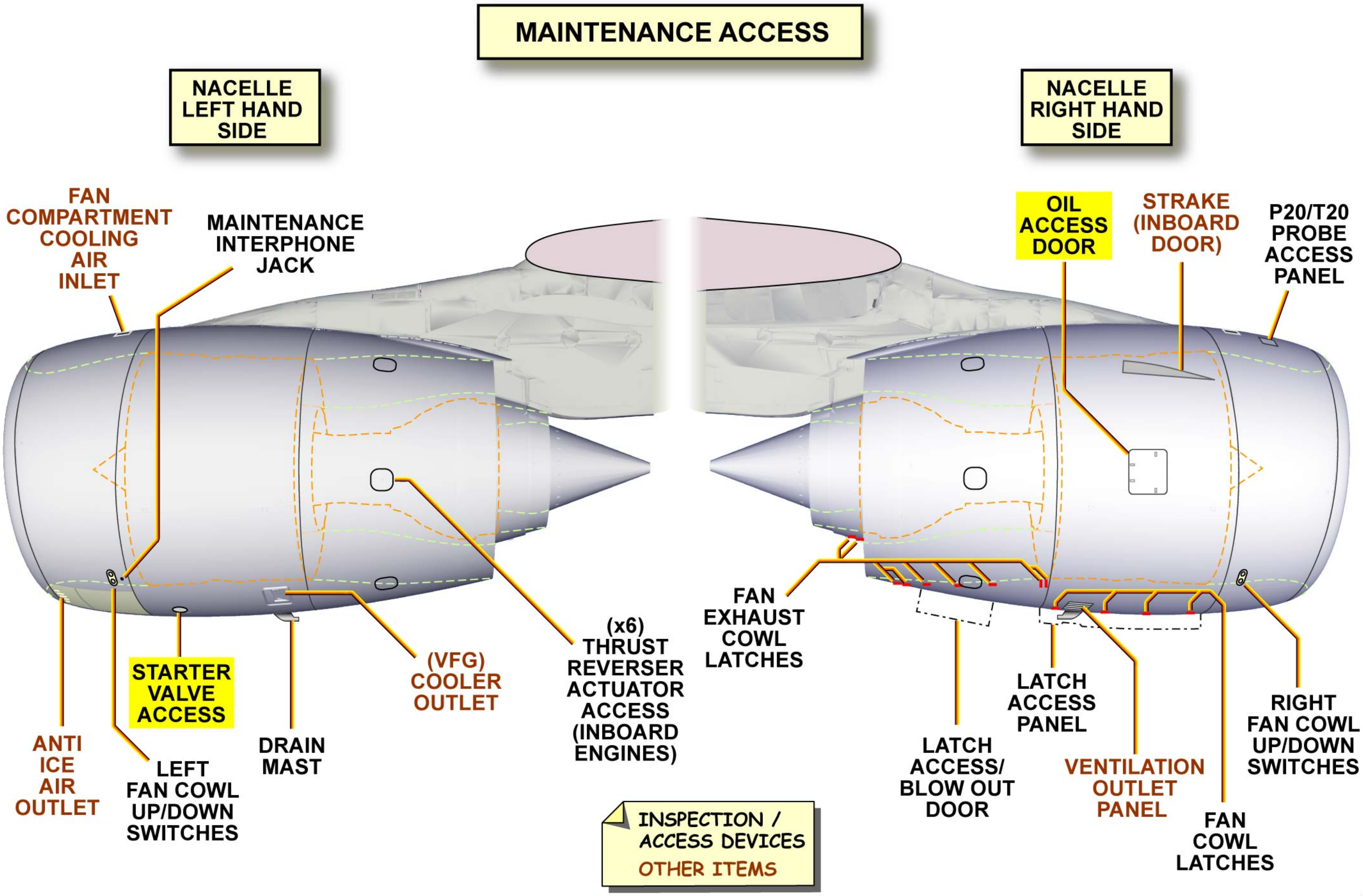
On the left fan cowl door there is:
- the starter valve access.

The left fan exhaust cowl has 3 accesses for the thrust reverser actuators.

Nacelle Right Side Access

On the right hand side of the air intake cowl there are:
- the right fan cowl up/down switches and,
- the P20/T20 probe access panel.

On the right fan cowl doors there is the oil access door panel and the fan cowl latch access panel.
At the bottom of the fan exhaust cowl there is the latch access / blow out door.
The right fan exhaust cowl has 3 access panels for the thrust reverser actuators.



MAINTENANCE ACCESS - NACELLE LEFT SIDE ACCESS & NACELLE RIGHT SIDE ACCESS

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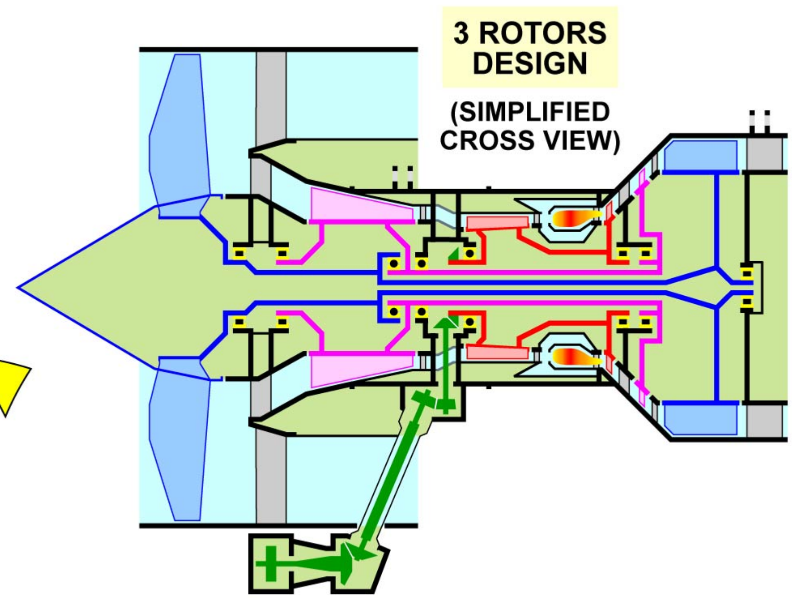
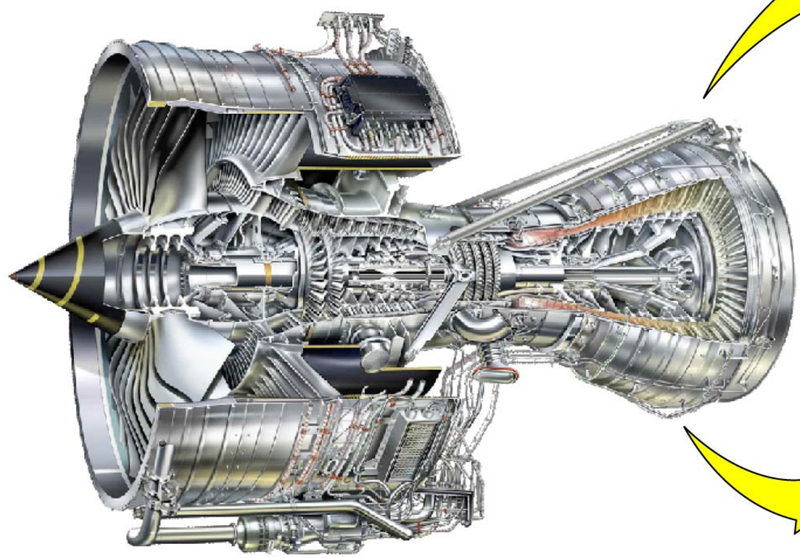
ENGINE PRESENTATION (1)

General

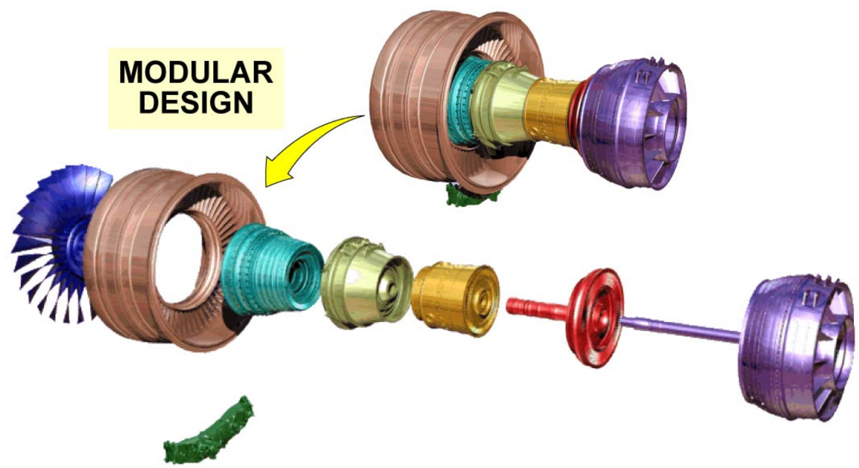
The Rolls Royce RB 211-TRENT 900 engine is designed to power the whole A380 Family with the same engine hardware.
The TRENT 900 is a high by-pass ratio turbofan, its architecture is based on 3 rotors and a modular design.
The Full Authority Digital Engine Control (FADEC) is installed on the engine. The FADEC supplies engine control and maintenance data.

- THE SAME ENGINE HARDWARE TO POWER THE WHOLE A380 FAMILY
- ENGINE CONTROL AND MAINTENANCE DATA BY FADEC
- HIGH BYPASS RATIO
- 3 ROTORS DESIGN
- MODULAR DESIGN





ROLLS ROYCE
RB211-TRENT 900



GENERAL

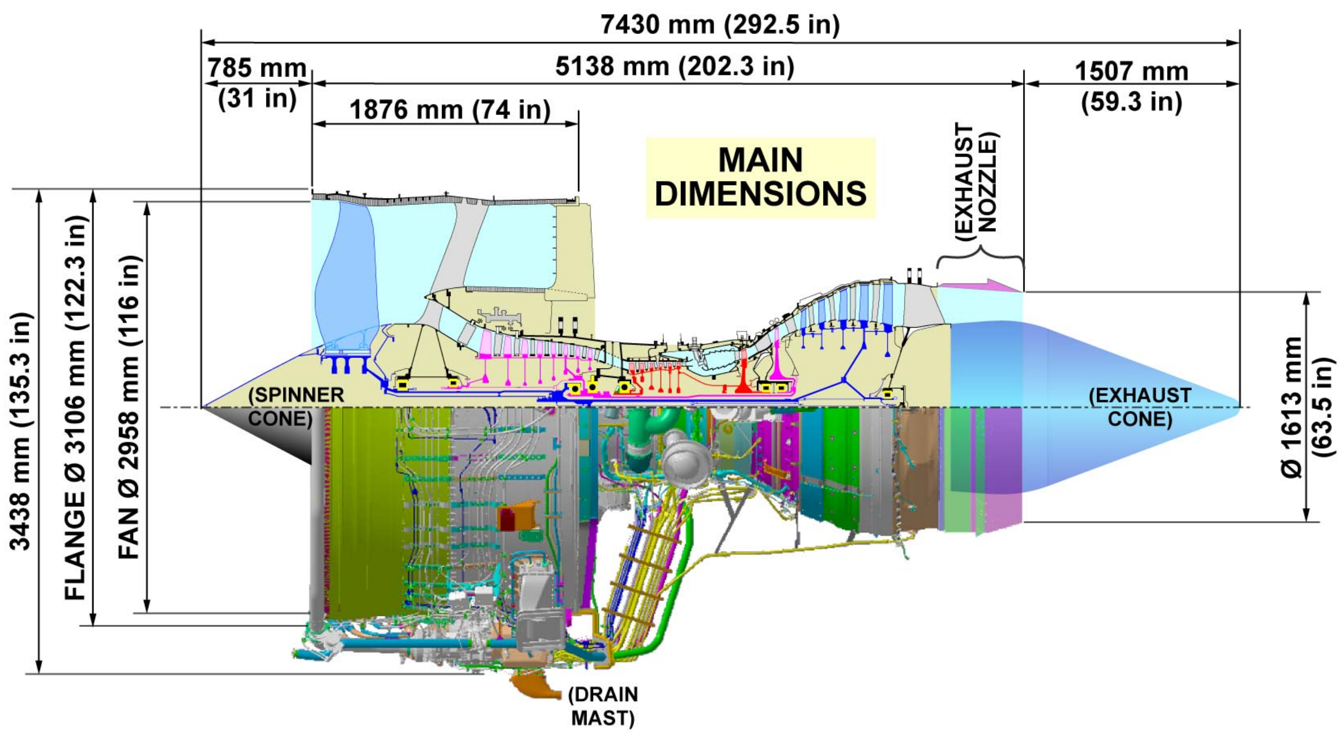
ENGINE PRESENTATION (1)

Main Characteritics

Each Aircraft model of the A380 Family has its dedicated ENGINE MARK.
A Data Entry Plug is attached to the engine and it is plugged to the FADEC. The Data Entry Plug (DEP) defines the ENGINE MARK and sets its related takeoff thrust.
The takeoff thrust, from 334.29 kN (75152 lb) to 374.09 kN (84098 lb) is flat rated at ISA+15ºC (59Fº).
The Pressure ratio (P30/P20) equals 47.1.
The Bypass ratio ( ) equals 8.12.

DIMENSIONS AND WEIGHT

Overall length of the engine from the front of the spinner cone to the rear of the exhaust cone is 7430 mm (292.5 in).
The LP compressor (or Fan) diameter is 2958 mm (116 in).
The maximum engine diameter, drain mast not included, is 3438 mm (135.3 in).
The weight of the dressed basic engine (dry) is approximately 6440 kg (141200 lb).



ENGINE MARK	TAKEOFF THRUST		AIRCRAFT MODEL
	kN	lb	
RB211-TRENT 970-84	334.29	75152	A380-841
RB211-TRENT 970B-84	348.31	78304	
RB211-TRENT 977-84	359.33	80781	A380-843F
RB211-TRENT 977B-84	372.92	83835	
RB211-TRENT 980-84	374.09	84098	
THE TAKEOFF THRUST IS FLAT RATED AT ISA+15°C (59°F)			

MAIN CHARACTERITICS:

- TAKEOFF THRUST SET BY DATA ENTRY PLUG (DEP)
- BYPASS RATIO (λ) : 8.12
- PRESSURE RATIO (P30/P20) : 41.7
- APPROXIMATE WEIGHT OF THE DRESSED BASIC ENGINE (DRY) : ~ 6440 kg (14200 lb)

MAIN CHARACTERITICS

ENGINE PRESENTATION (1)

Rotors

The engine has3 rotors:
- Low Pressure (LP) rotor,
- Intermediate Pressure (IP) rotor,
- High Pressure (HP) rotor.

The rotors are supported by 8 bearings, 2 types of bearings are used:
- Ball bearings also called location bearings support both radial and axial loads.

-.Roller bearings support radial loads and give axial thermal expansion.

LP Rotor

The LP rotor has a single stage LP compressor driven by a 5-stage LP turbine.
The LP compressor, also called fan, has 24 wide-chord blades that are engaged in axial dovetail slots in the LP compressor disk.
For the blade replacement access you have to remove the spinner cone.
The LP compressor supplies most of the engine thrust.
The LP rotor is supported by 3 bearings
- 1 roller bearing at the rear of the LP compressor disk.
- 1 ball bearing close to the mid length of the LP rotor. Note that this bearing is an inter shaft bearing between the LP and IP rotor shafts.
- 1 roller bearing at the LP turbine rear end.

The LP rotor speed is called N1. It turns in counter clockwise direction when viewed from the rear.

IP Rotor

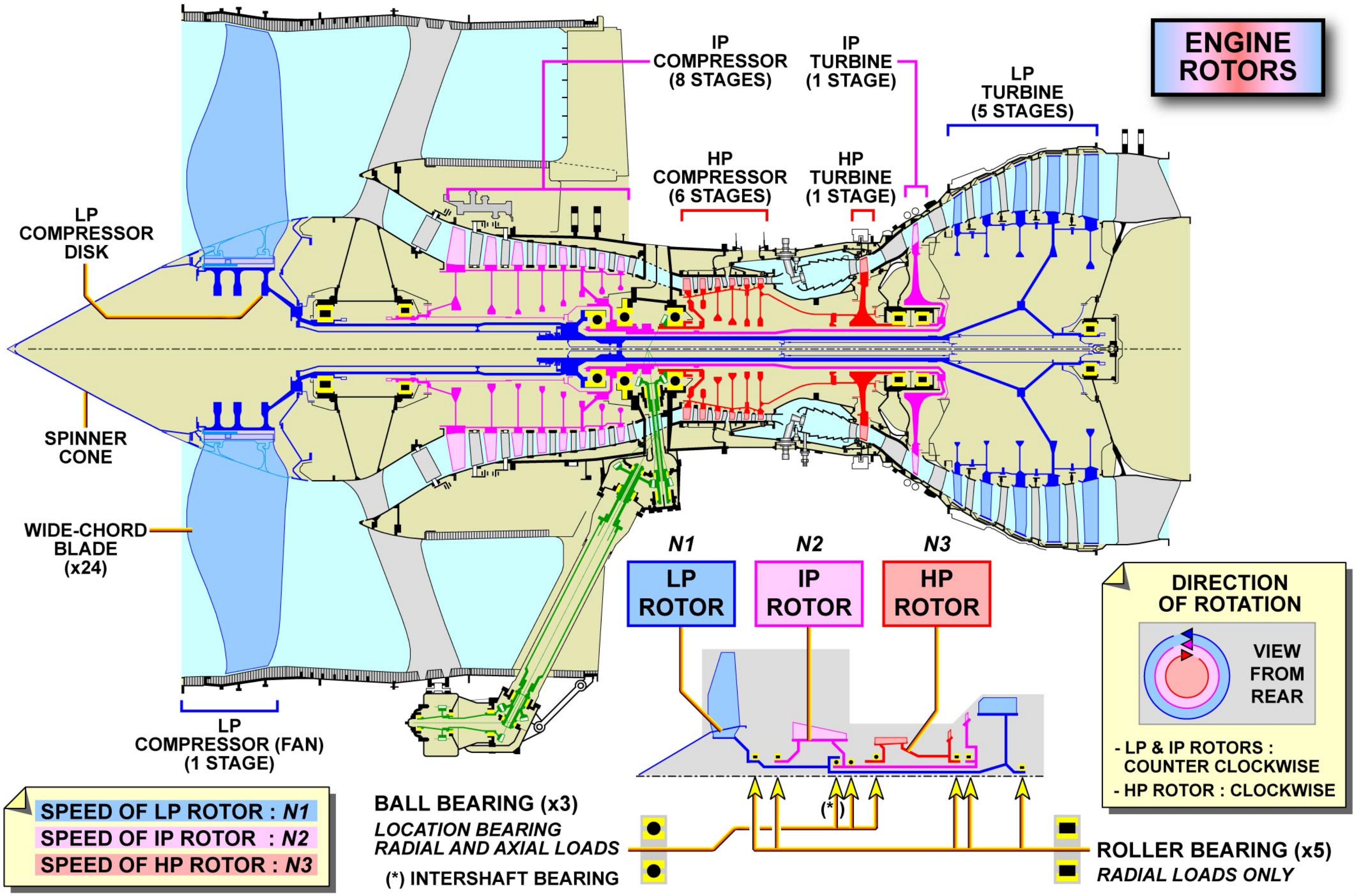
The IP rotor has an 8-stage compressor driven by a single stage turbine.
It is supported by 3 bearings:
- 1 roller bearing at the front end of the IP compressor.
- 1 ball bearing at the IP compressor rear part, around the mid length of the IP rotor.
- 1 roller bearing at the level of the IP turbine.

The IP rotor speed is called N2. It turns in counter clockwise direction when viewed from the rear.

HP Rotor

The HP rotor has a 6-stage compressor driven by a single stage turbine.
It is supported by 2 bearings:
- 1 ball bearing at the HP compressor front end.
- 1 roller bearing at the HP turbine rear end.

The HP rotor speed is called N3. It turns in clockwise direction when viewed from the rear.



ROTORS - LP ROTOR ... HP ROTOR

ENGINE PRESENTATION (1)

Structure And Fairings

The engine structure carries the loads from the rotors through the bearing supports and sends the engine loads to the pylon through the engine mount lugs.
The engine mounts lugs are installed on 2 main structural parts:
- the intermediate case and,
- the tail bearing housing support structure.

Several casings link these 2 main structural parts: the combustion outer case, the HP/IP turbine case and the LP turbine case.
The intermediate case supports the IP compressor case and the LP compressor case.
Various fairings called gas generator fairings are installed on the engine structure.

Bearing Supports

There are 4 bearing supports among the engine structural elements:
- The front bearing housing. The loads are transmitted to the intermediate case via the engine section stator vane, then via the IP compressor case.
- The support structure of the location bearings located in the intermediate case.
- The HP/IP turbine bearing support structure. It transmits the loads to the various core casings via the IP nozzle guide vane assembly.
- The LP turbine bearing support structure. It has the tail bearing housing support structure.

Intermediate Case

The intermediate case has engine front mount lugs and the engine thrust lugs.
The front mount lugs support most part of engine weight and lateral loads.
The thrust lugs located on each side of the case transmit the engine thrust.

Tail Bearing Housing Support Structure

The tail bearing support structure has the engine rear mount lugs.
The rear mount lugs support a part of engine weight, lateral loads and the engine torque loads.
The outer and inner rear flanges are used to install the exhaust nozzle and cone.

Combustion System

The main elements of the combustion system are:
- the combustion outer case,
- the combustion inner case,
- the combustion chamber and
- the HP nozzle guide vane assembly.

The combustion system has the fuel spray nozzles.

LP Compressor Case

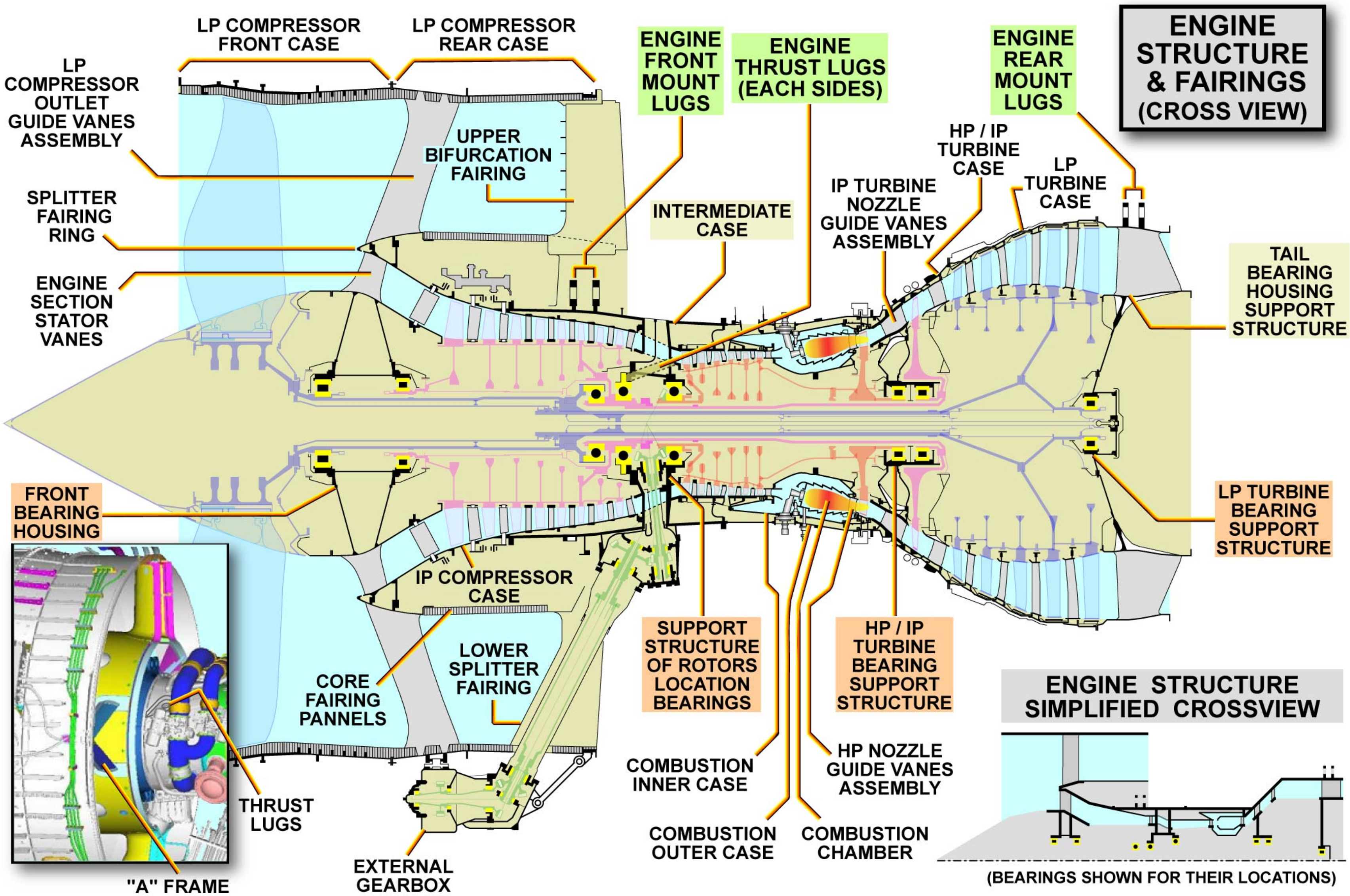
The LP compressor case has a front case and a rear case. It is attached on the IP compressor case and the intermediate case.
The loads supported by the IP compressor case go through the LP compressor outlet guide vanes assembly then trough the splitter fairing ring.
The loads directly supported by the intermediate case go through the "A" frame.
The front flange of the LP compressor case is used to install the intake cowl.
The external gearbox is mounted on the LP compressor case assembly
The LP compressor case supplies support for many units of engine systems.

Gas Generator Fairings

The gas generator fairings include the core fairing, the upper bifurcation fairing and lower splitter fairing.

There are 6 core fairings. They supply an aerodynamically smooth flow path between the splitter fairing ring and the inner barrel of the fan exhaust cowls.

The upper bifurcation fairing and lower splitter fairing form leading edges that split the fan airflow into the 2 fan exhaust cowls.



STRUCTURE AND FAIRINGS - BEARING SUPPORTS ... GAS GENERATOR FAIRINGS

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ENGINE PRESENTATION (1)

Accessory Drive Section

The accessory drive section transmits the mechanical power from the HP rotor to the accessory units installed on the accessory gearbox.
The power from the HP rotor goes successively through:
- the internal gearbox,
- a radial shaft,
- the intermediate gearbox,
- the external gearbox drive shaft,
- the transfer gearbox and,
- the accessory gearbox.

INTERNAL GEARBOX

The internal gearbox is installed inside the intermediate case.

INTERMEDIATE GEARBOX

The intermediate gearbox is bolted beneath the intermediate case.

EXTERNAL GEARBOX DRIVE SHAFT

A shroud tube surrounds the external gearbox drive shaft. The upper part of the shroud tube is flange mounted on the intermediate gearbox and its lower part is flange mounted on the transfer gearbox. The shroud tube protects for the external gearbox drive shaft, oil scavenge and gearbox pressurization.

EXTERNAL GEARBOX

The external gearbox is made of the transfer gearbox and the accessory gearbox.
The external gearbox assembly is attached and located beneath the LP compressor case, using 4 clevis mounts and a spigot.
The accessory gearbox has gear shafts that drive airframe and engine accessories. Each gear shaft is an individually replaceable plug-in type unit, which fits into the face of gearbox housing.

At the forward tip of the input gear shaft, the gearbox is supplied with a hand turning port, it is used to manually drive the HP rotor for maintenance task.
The sealing of the accessory drives is done by air blown seal.

Location Of Accessories

Both front and rear faces of the accessory gearbox are supplied with mounting pads for accessory installation.

ACCESSORIES INSTALLED ON THE FRONT FACE:

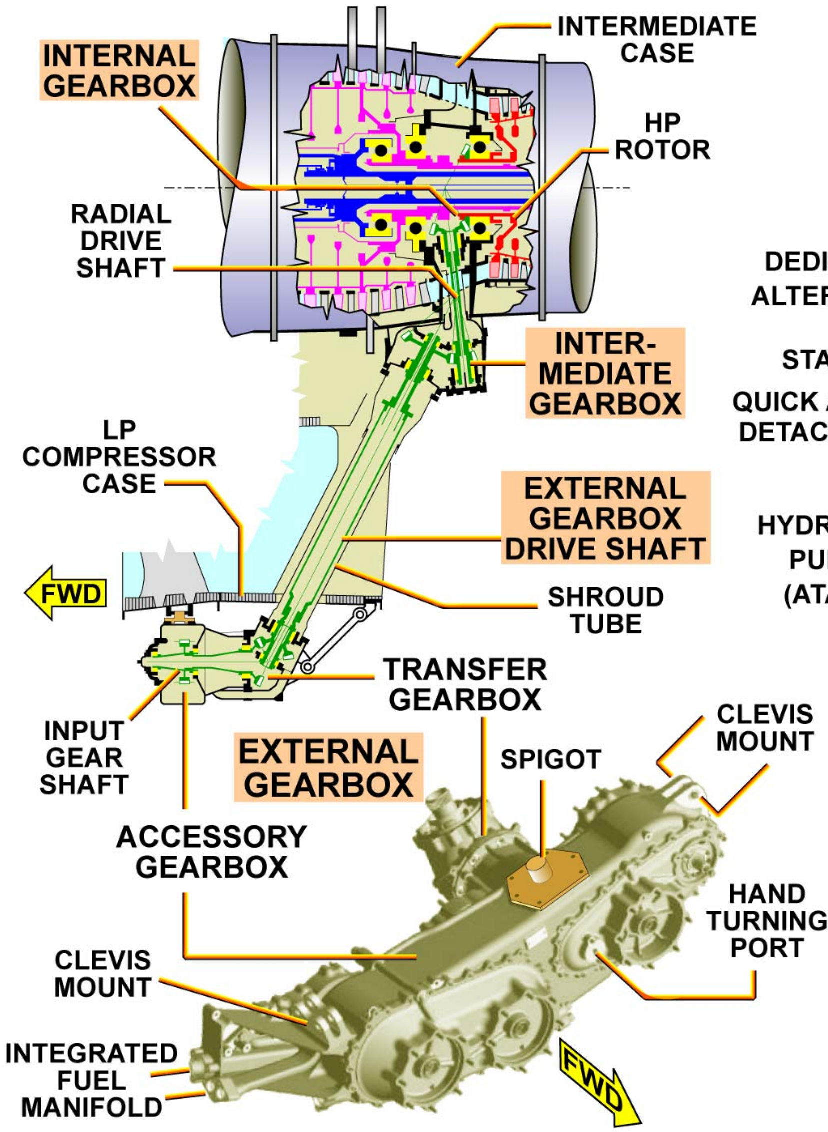
- Dedicated alternator (FADEC),
- Starter,
- Hydraulic pumps 1 and 2 (ATA29).

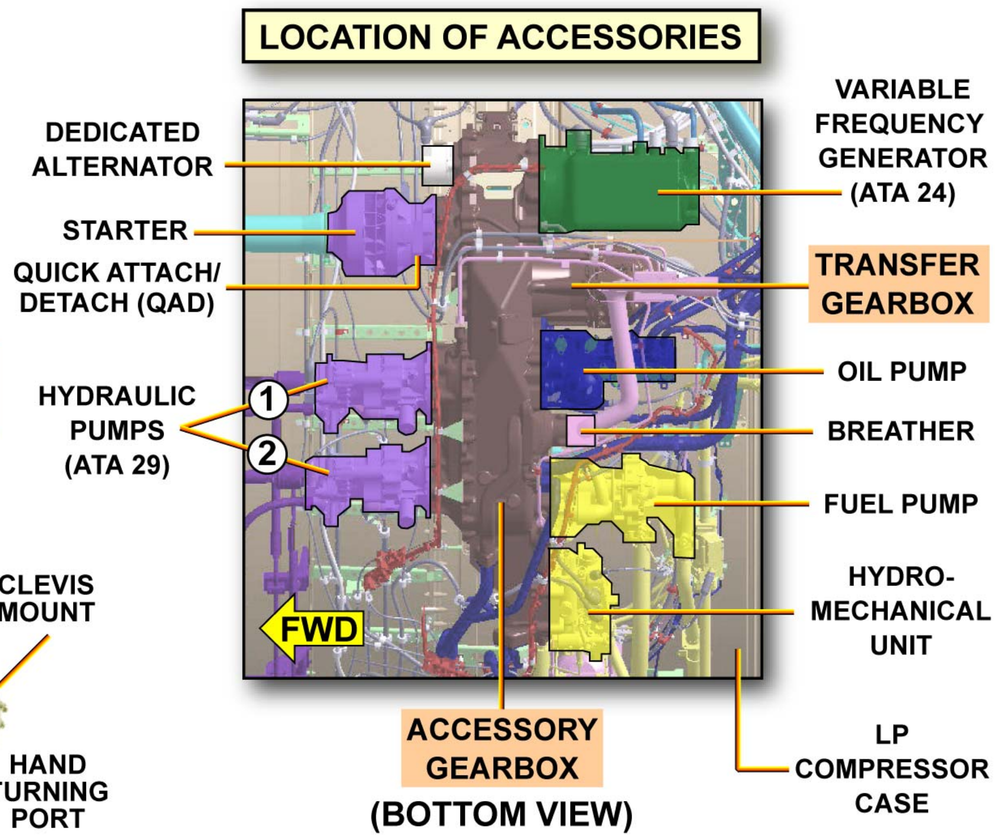
Note that the starter is installed with a Quick Attach/Detach (QAD) ring.

ACCESSORIES INSTALLED ON THE REAR FACE:

- Variable Frequency Generator (ATA 24),
- Oil pump,
- Breather,
- Fuel pump.
- Hydro mechanical unit.

The right hand side of the gearbox housing integrates a fuel manifold with internal fuel flow supply both fuel pump and HMU.
Notice that the HMU is not mechanically driven by the accessory gearbox. The HMU is only hydraulically connected.





ACCESSORY DRIVE SECTION - LOCATION OF ACCESSORIES

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ENGINE PRESENTATION (1)

Modular Design

The basic engine is an assembly of 8 primary units that are identified as modules.
These modules can be independently replaced at modular maintenance level and are specified as follows:
Module 01: LP compressor rotor.
Module 02: IP compressor.
Module 03: Intermediate case.
Module 04: HP system (combustion system and HP rotor).
Module 05: IP turbine.
Module 06: External gearbox.
Module 07: LP compressor case
Module 08: LP turbine.

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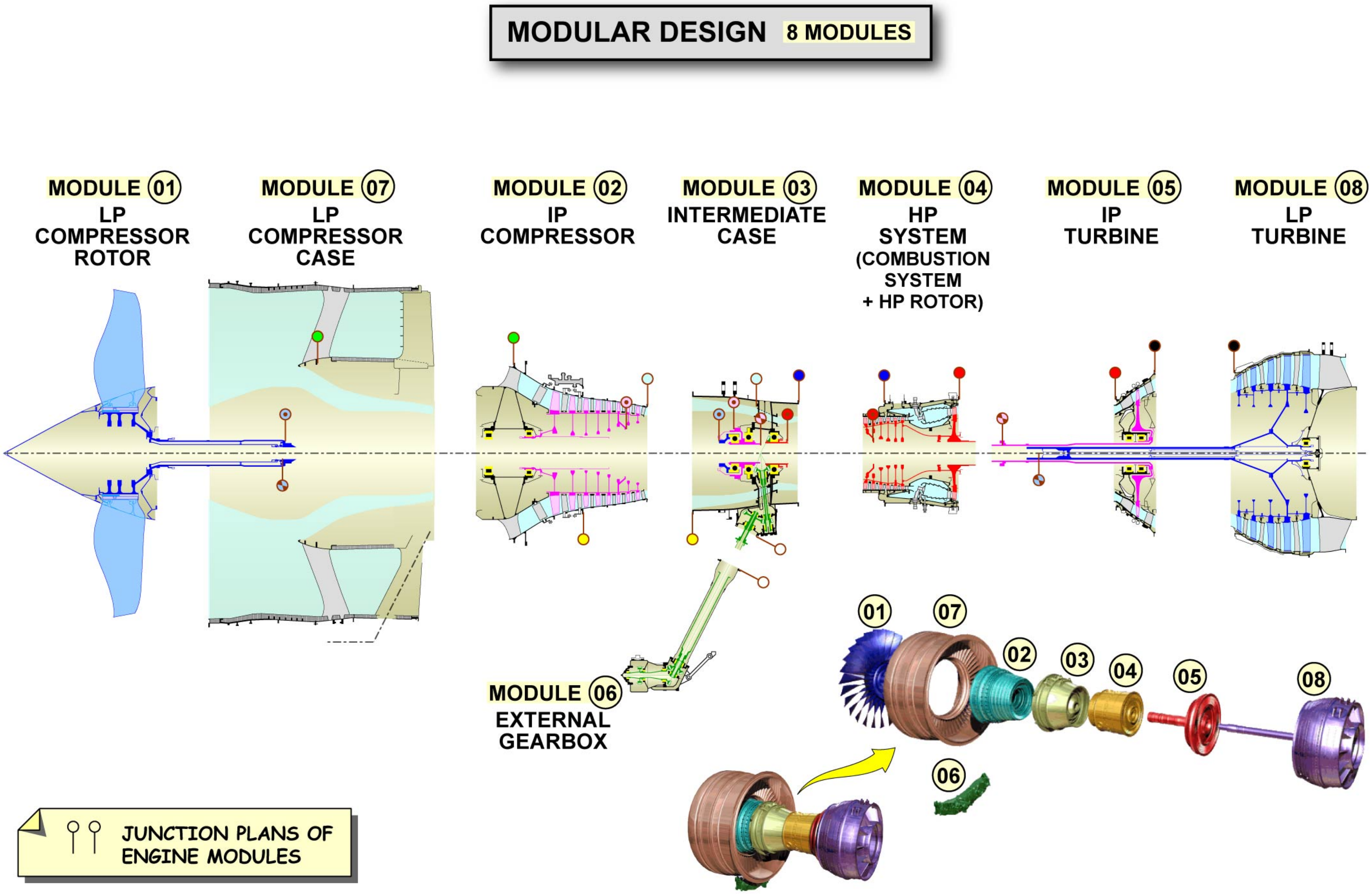


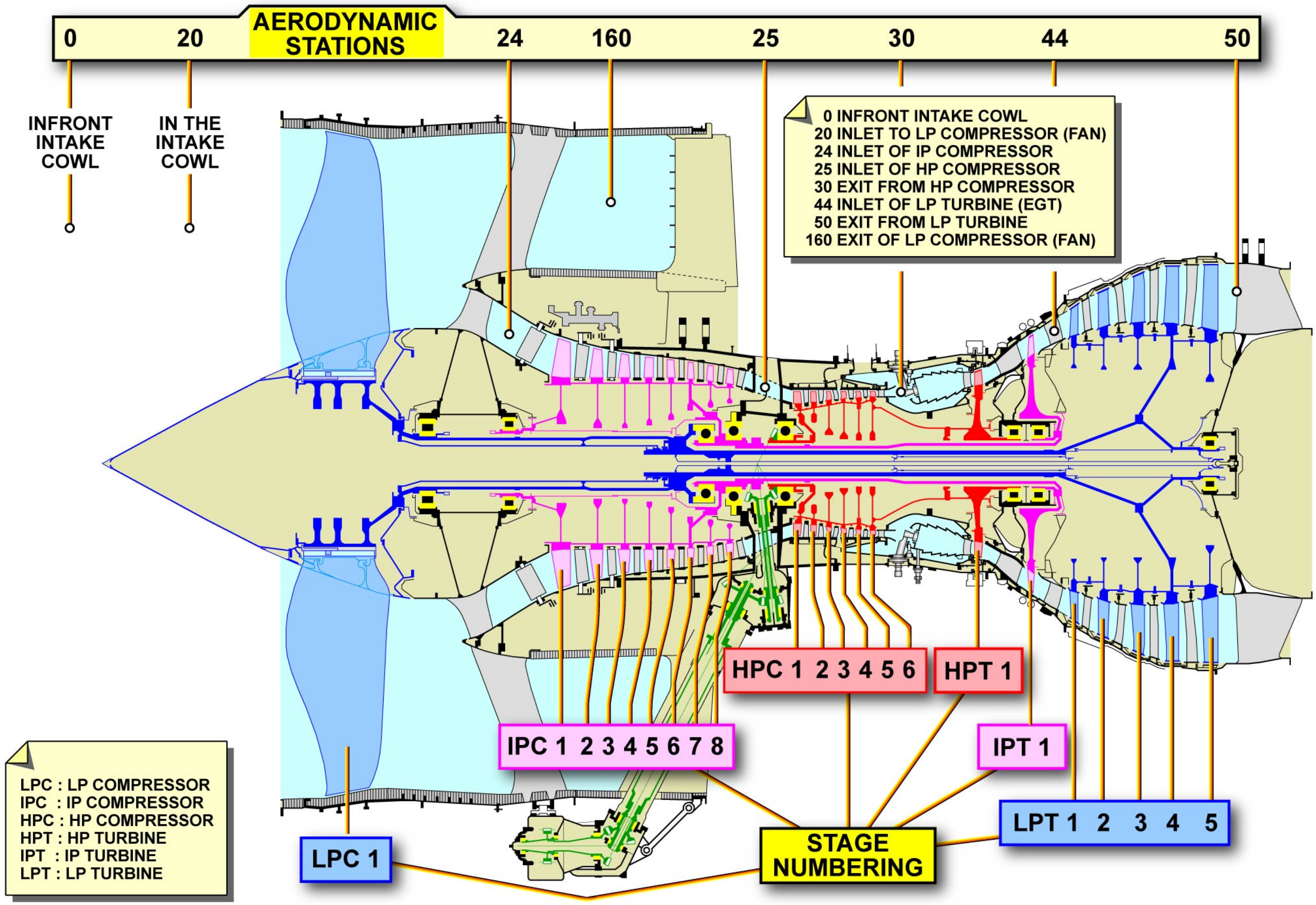
MODULAR DESIGN

ENGINE PRESENTATION (1)

Aerodynamic Stations And Stage Numbering

Here are the aerodynamic stations mainly related to the pressure and temperature sensors installed on the engine:
- 0: in front intake cowl,
- 20: inlet to LP compressor (fan)
- 24: inlet of IP compressor,
- 25: inlet of HP compressor,
- 30: exit from HP compressor,
- 44: inlet of LP turbine (EGT),
- 50: exit from LP turbine,
- 160: exit of LP compressor (fan).

The compressor and turbine stages are numbered as follows:
- LP Compressor (fan): LPC1,
- IP Compressor: IPC1 to IPC8,
- HP Compressor HPC1 to HPC6
- HP Turbine: HPT2
- IP Turbine: IPT1
- LP Turbine: LPT1 to LPT5.

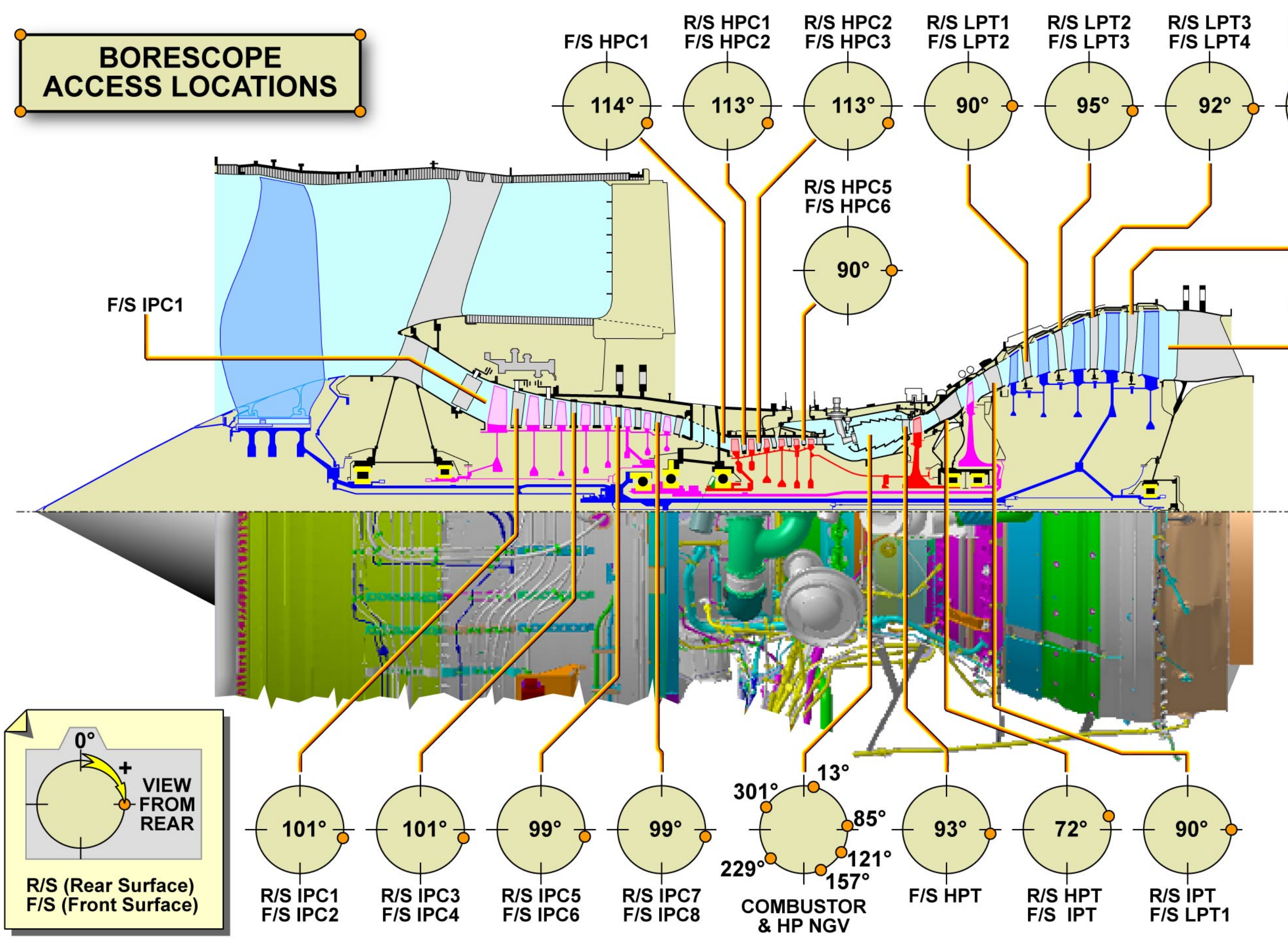


AERODYNAMIC STATIONS AND STAGE NUMBERING

ENGINE PRESENTATION (1)

Borescope Access Locations

You can use borescope equipment to visually examine the engine at different positions.
It is possible to examine the compressor and turbine blades, the internal walls of the combustion liner and the HP nozzle guide vanes.
Note that most of borescope accesses are located on the right hand side of the engine.



BORESCOPE ACCESS LOCATIONS

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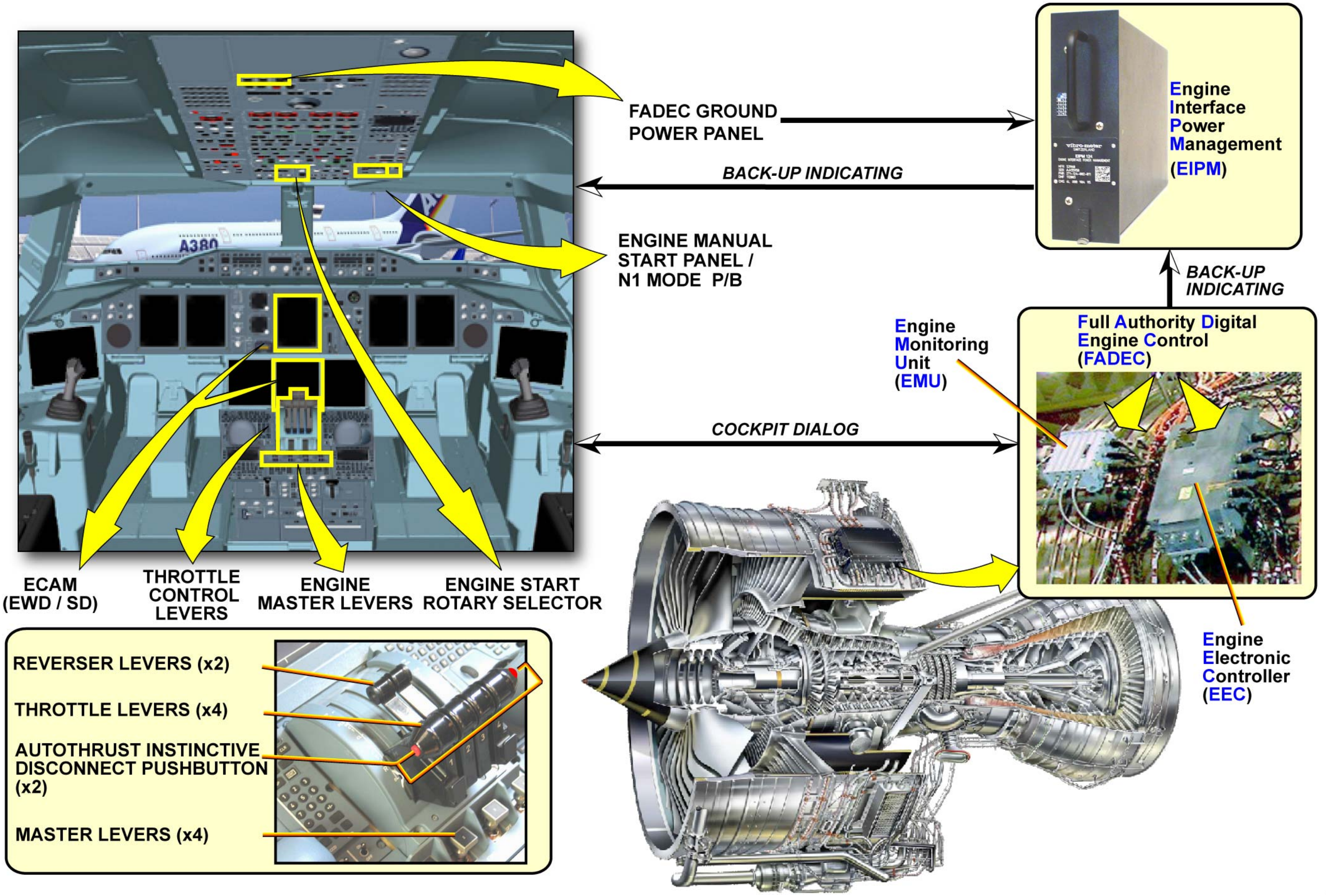
ENGINE CONTROL & INDICATING PRESENTATION (1)

General

The engine controls are located on the overhead panel and on the center pedestal.
The engine controls are:
-The throttle control levers,
-The engine master levers,
-The engine start rotary selector,
-The man start pushbutton,
-N1 mode selection pushbutton,
-The FADEC ground power pushbutton.
The engine parameters are displayed on the ECAM, which is divided over two screens, the Engine Warning Display (EW/D) and the System Display (SD).
In case of network failure the Engine Electronic Controller (EEC) and the Engine Interface Power Management (EIPM) are linked to keep the engine parameters indication.


FADEC GROUND POWER PANEL
BACK-UP INDICATING
ENGINE MANUAL START PANEL / N1 MODE P/B
Engine Interface Power Management (EIPM)
BACK-UP INDICATING
Full Authority Digital Engine Control (FADEC)
Engine Monitoring Unit (EMU)
COCKPIT DIALOG
ECAM (EWD / SD)
THROTTLE CONTROL LEVERS
ENGINE MASTER LEVERS
ENGINE START ROTARY SELECTOR
REVERSER LEVERS (x2)
THROTTLE LEVERS (x4)
AUTOTHRUST INSTINCTIVE DISCONNECT PUSHBUTTON (x2)
MASTER LEVERS (x4)
Engine Electronic Controller (EEC)
A380

GENERAL

ENGINE CONTROL & INDICATING PRESENTATION (1)

Throttle Control Assembly

The Throttle Control Assembly (TCA) is a single mechanical box assembly. The primary function of the TCA is to sense throttle control lever position.
It features four throttle levers. There are two reverser levers one for each inboard engine.
There are soft detents, which agree with thrust settings (idle, max climb / derated climb, max continous / flexible go around / flex take-off / derated take-off, max take-off, reverse idle, max reverse).
In both automatic and manual thrust setting modes, the selection of the throttle levers to full forward position leads the FADEC system to set the engine at max available power.

Engine Master Levers

The ENGine MASTER lever (one per engine) is the primary control to initiate engine start sequence and to shut down the engine
The ENGine MASTER lever is hardwired to the fuel High Pressure Shut-Off Valve (HPSOV) and to each channel of the EEC.
A "FAULT" indication is situated at the top of the ENGine MASTER lever; this indication is managed by the EIPM, based on digital data received from the related EEC.

Engine Start Rotary Selector

The ENGine START rotary selector is a single cockpit command for the four engines. It is positioned on the overhead panel and has three positions, "CRANK", "NORM" and "IGN START".

CRANK

The CRANK position allows wet or dry motoring of the engine.

NORM

The NORM position is the usual position selected after engine start. The FADEC can operate the ignition systems in this position for auto relight/flameout.

IGN START

The IGN START position is used to initiate automatic or manual starts

Engine Man Start PushButtons

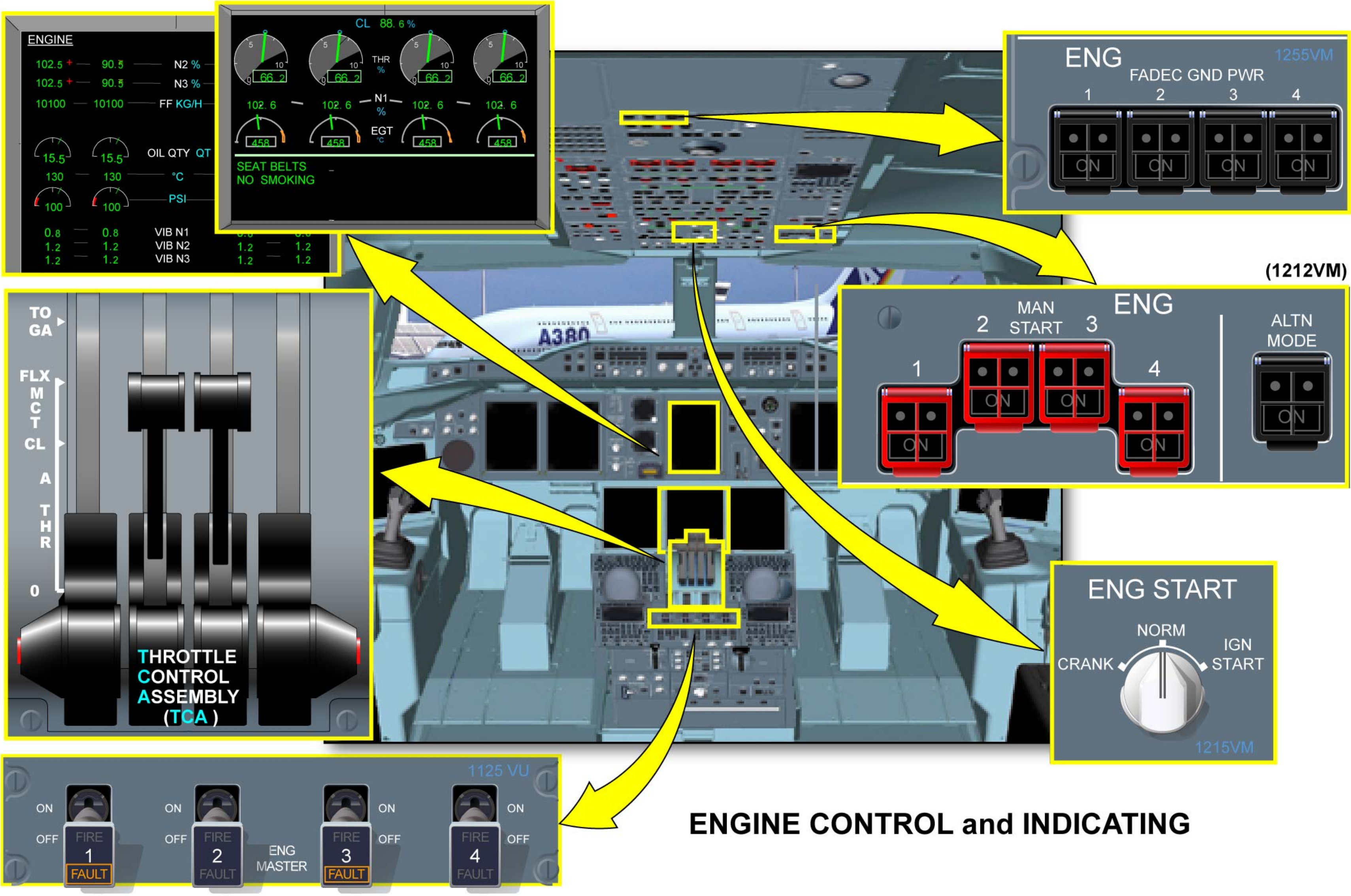
The MANual START pushbutton is used to inform the EEC to operate the related start valve for a manual starting sequence (when the engine start rotary selector is set to IGN START) or to crank the engine (when the engine start rotary selector is set to CRANK).

N1 Mode Selection: Alternate Mode

A single N1 pushbutton interfaces with the four EECs. This pushbutton is labeled as ALTerNate MODE on the overhead panel. This pushbutton is used to force or confirm the engines to operate in N1 back up mode, when the EEC detects a failure of the primary engine control mode.

FADEC Ground Power PushButton

The FADEC GrouND PoWeR pushbutton is directly connected to the EIPM. The EIPM maintains the EEC and the Engine Monitoring Unit (EMU) airframe power supply for 5 minutes to make ground maintenance test/check.



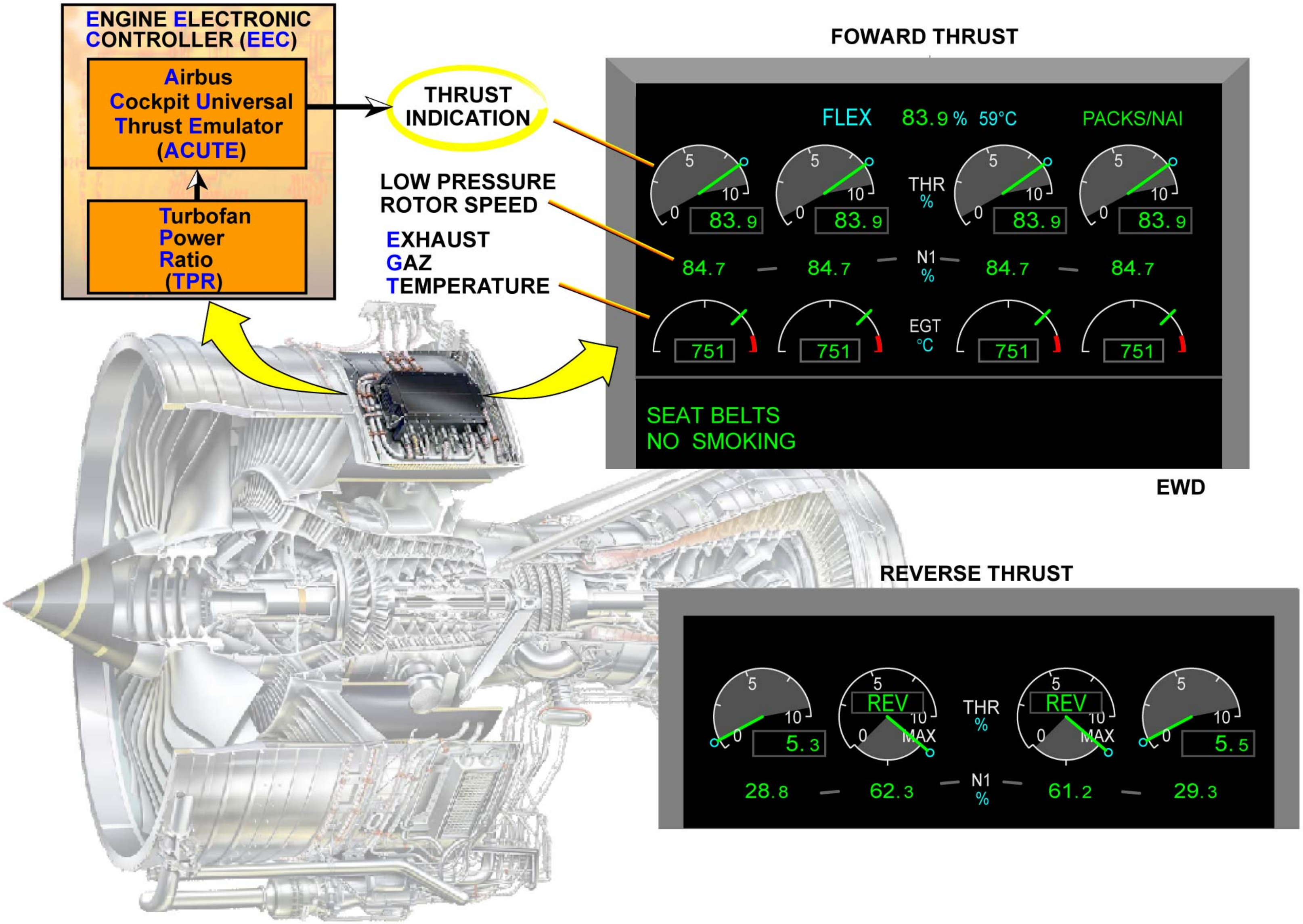
ENGINE CONTROL and INDICATING

THROTTLE CONTROL ASSEMBLY ... FADEC GROUND POWER PUSHBUTTON

ENGINE CONTROL & INDICATING PRESENTATION (1)

Engine Primary Indication

The main parameters, THRust (THR), low pressure rotor (Fan) speed N1, and the Exhaust Gas Temperature (EGT), are displayed on the Engine Warning Display (EWD).
The engine power indication is named thrust "THR", it is derived from the ratio P30 to P20 corrected by TGT and T20. THR is expressed as a percentage of thrust available (for the forward power operation and for the reverse power operation).
The thrust indication comes from an EEC processing function named ACUTE (Airbus Cockpit Universal Thrust Emulator).
The Turbofan Power Ratio (TPR) is the preliminary parameter to compute the thrust indication.(TPR is not displayed in the cockpit).
100% of thrust represents the maximum available thrust.



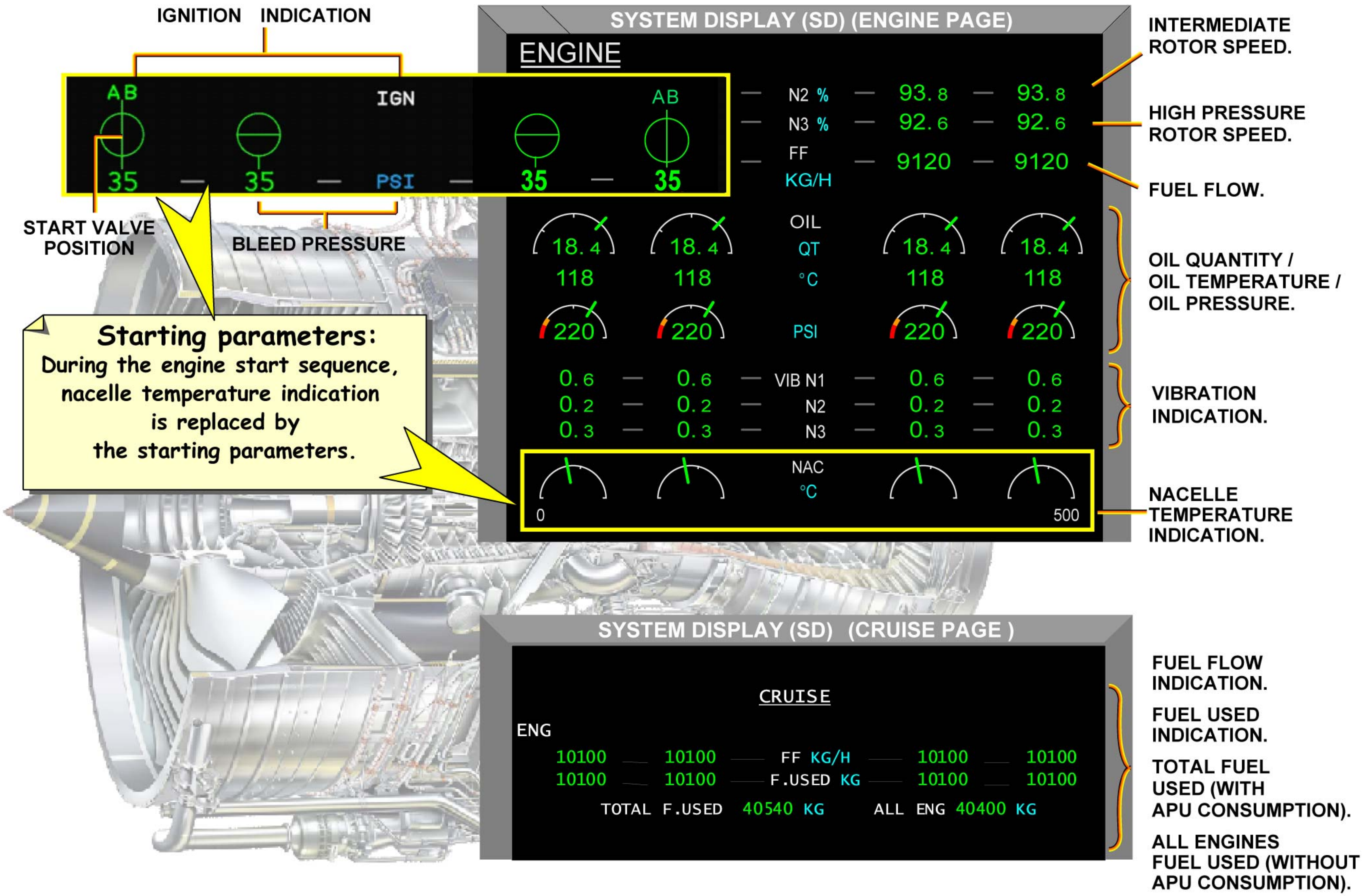
ENGINE PRIMARY INDICATION

ENGINE CONTROL & INDICATING PRESENTATION (1)

Engine Secondary Indication

The secondary parameters are shown on the System Display (SD), through the ENGINE page or the CRUISE page.
They are:
- The intermediate rotor speed N2,
- The high pressure rotor speed N3,
- The fuel flow (F/F),
- Oil quantity (OIL QTY), oil pressure (OIL PRESS), oil temperature (OIL TEMP),
- Vibration indication (VIB N1), (VIB N2), (VIB N3),
- Nacelle temperature (NAC),

During the start sequence the engine nacelle temperature indication is replaced by the starting parameters.
The CRUISE page displays the fuel flow (FF), the fuel used (F. USED), the APU and engine consumption (TOTAL F. USED), engine consumption without APU (all ENG).



ENGINE SECONDARY INDICATION

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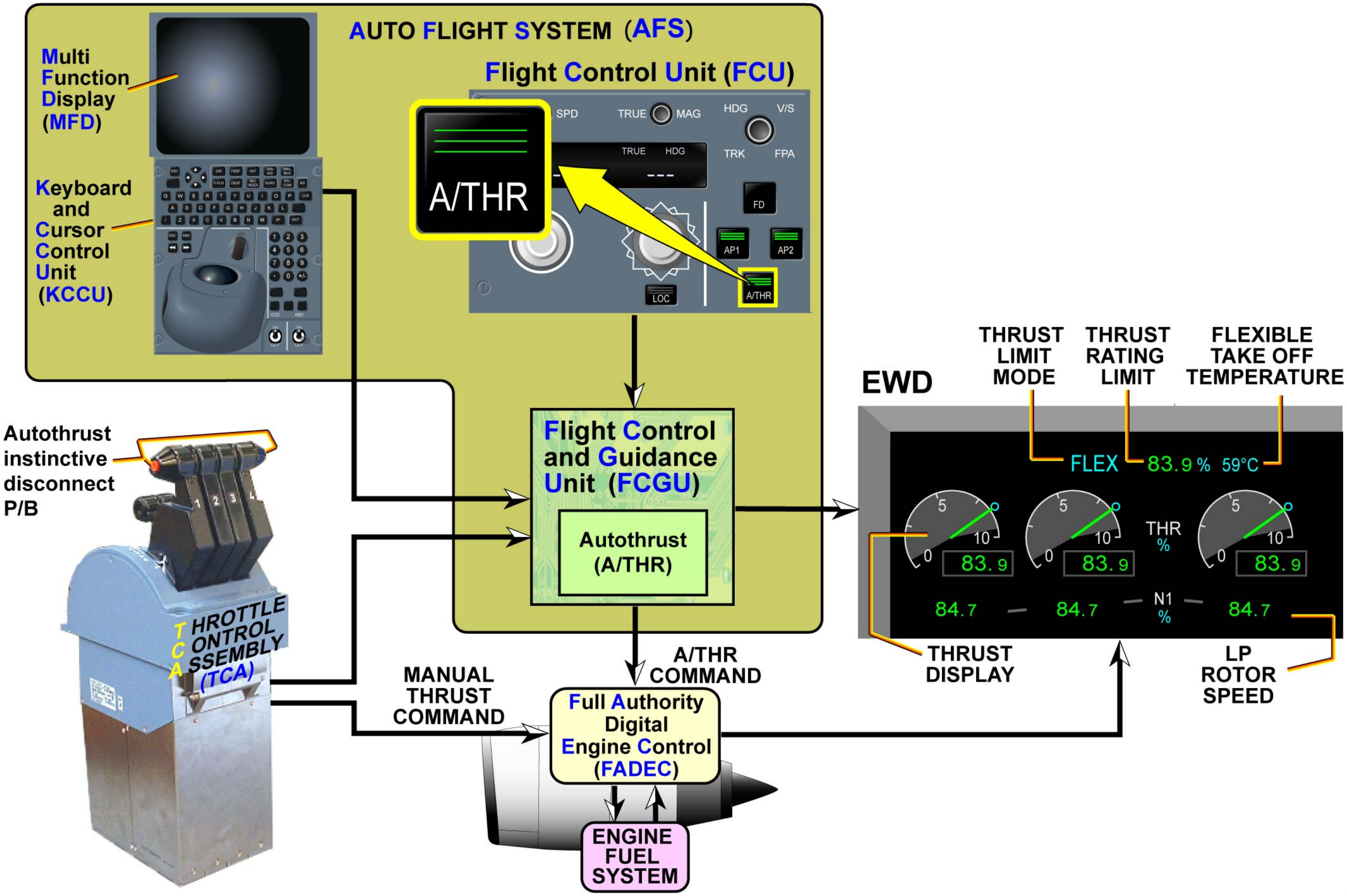
ENGINE CONTROL & INDICATING PRESENTATION (1)

Thrust Control

The thrust control fulfills the following functions:
- Modulation of engine thrust in manual mode, according to throttle control lever position,
- Thrust management in Auto THRust (A/THR) mode, according to thrust request coming from the Flight Control and Guidance Unit (FCGU),
- Instinctive disconnection of A/THR.

The Keyboard And Cursor Control Unit (KCCU) and the Multi Function Display (MFD) are used to set the necessary data to make a derated take-off or a flexible take off.



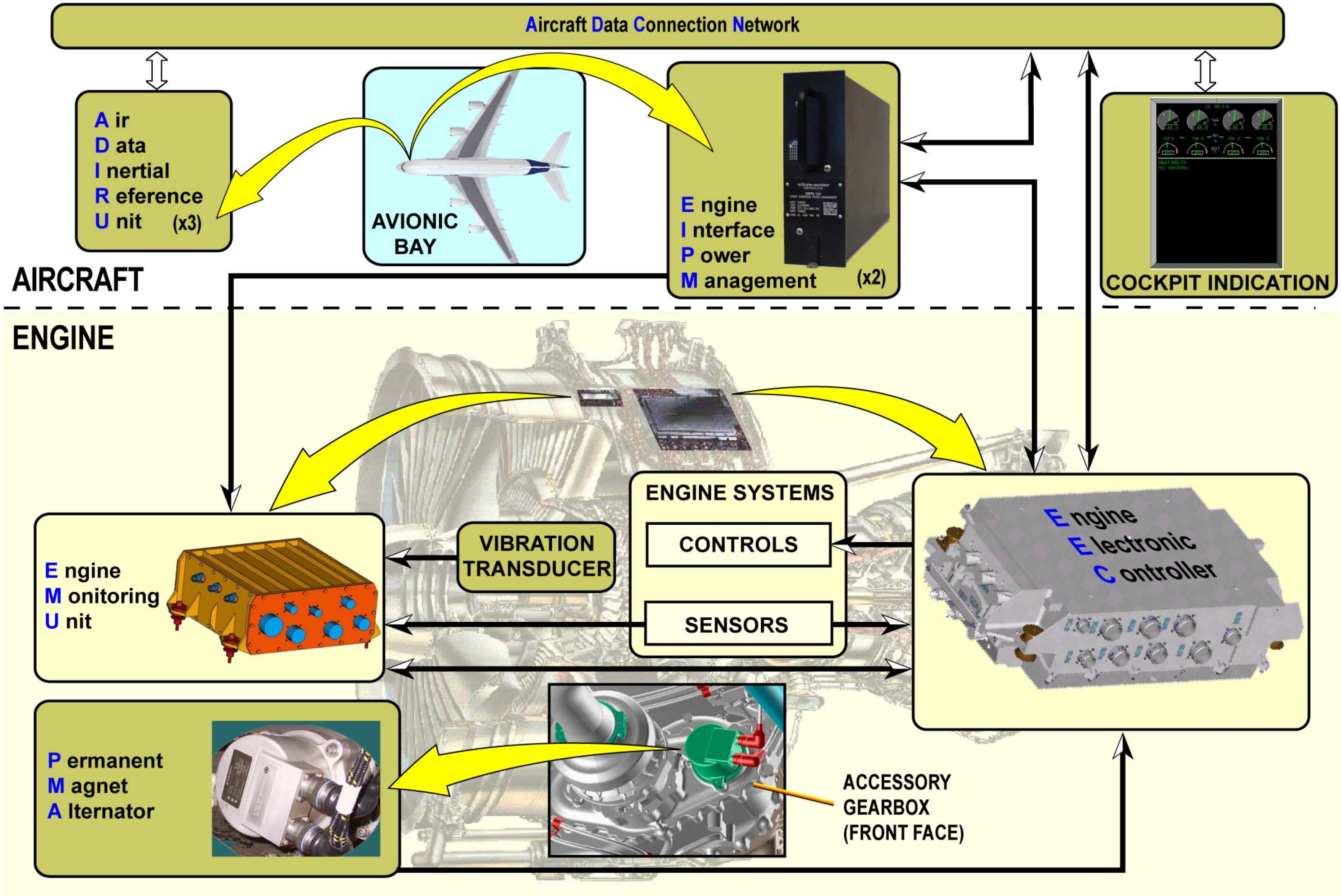
THRUST CONTROL

FADEC & EIPM PRESENTATION (1)

General

The FADEC includes two engine-mounted units:
- Engine Electronic Controller (EEC), including two independents channels.
- Engine Monitoring Unit (EMU) fulfills the vibration monitoring function for the cockpit display and the engine health monitoring for advanced engine maintenance functions.

The EEC receives inputs from the cockpit, aircraft sensor and engine sensors to control the engine and to give engine information to the aircraft systems. The EEC is connected to the Avionics Data Communication Network (ADCN).
The EEC manages the engine thrust according to Air data parameters and cockpit controls.
The EEC dialogs with the Air Data Inertial Reference Units (ADIRUs) through the ADCN network to make the air data selection logic.
The Engine Interface Power Management (EIPM) controls and delivers electrical power supplies from the aircraft to the engine EEC, the EMU and to the engine systems.
The EEC can be powered by an engine driven Permanent Magnetic Alternator (PMA) or from aircraft power via the EIPM.


Aircraft Data Connection Network
A ir
D ata
I nertial
R eference
U nit (x3)
AVIONIC
BAY
E ngine
I nterface
P ower
M anagement (x2)
COCKPIT INDICATION
AIRCRAFT
ENGINE
ENGINE SYSTEMS
CONTROLS
SENSORS
VIBRATION
TRANSDUCER
E ngine
M onitoring
U nit
E ngine
E lectronic
C ontroller
P ermanent
M agnet
A lternator
ACCESSORY
GEARBOX
(FRONT FACE)

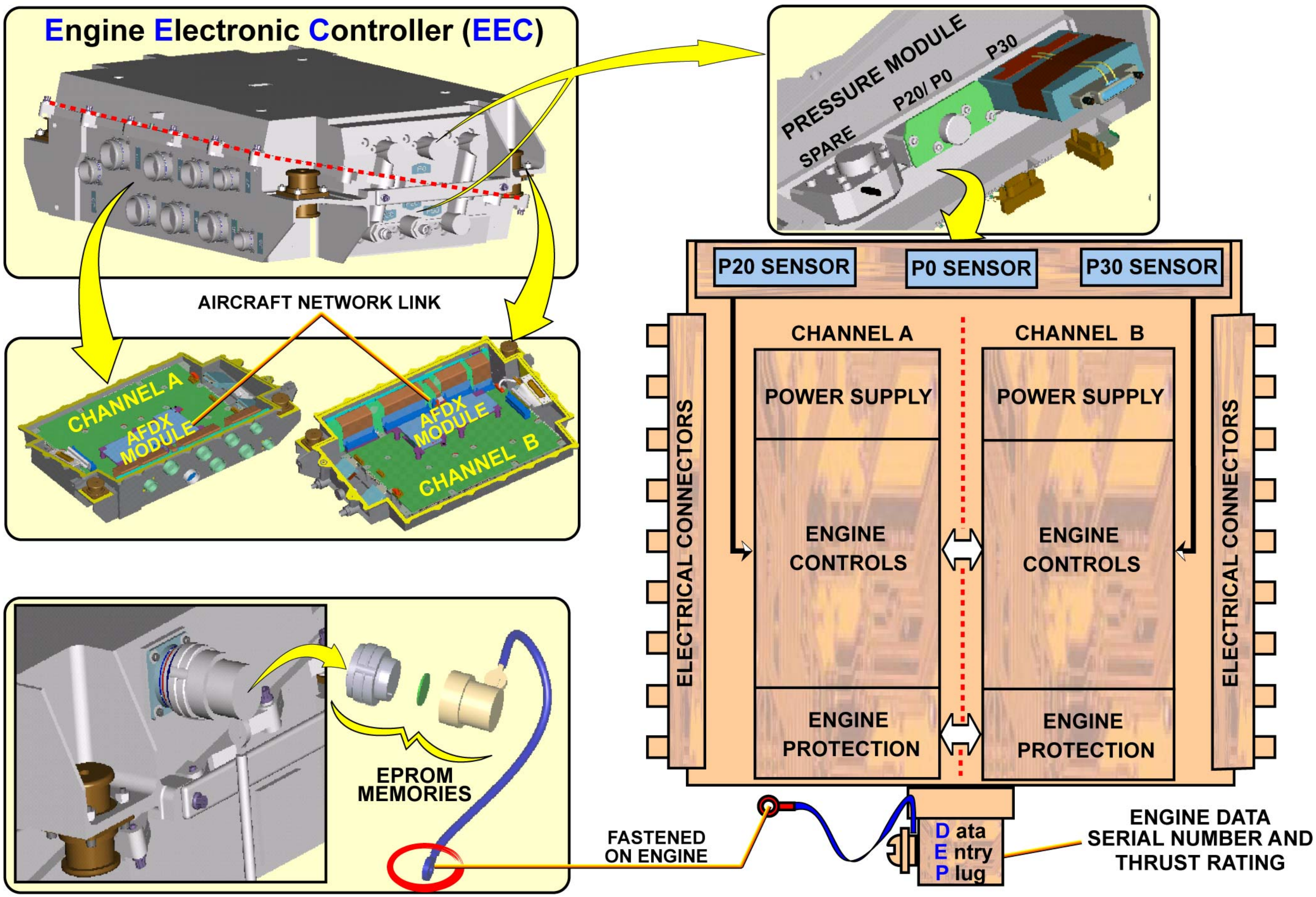
GENERAL

FADEC & EIPM PRESENTATION (1)

EEC Architecture

The EEC is installed on the fan case of the engine. The EEC is a digital unit made of two redundant channels named channel A and B.
Each EEC channels are composed of the following parts:
- The powers supply board,
- The pressure module,
- Engine control module,
- Engine protection module,
- The Avionics Full Duplex Switched Ethernet (AFDX) board and,
- The electrical connectors board.

The Data Entry Plug (DEP) supplies the individual characteristics of the engine; the DEP is fastened to the engine fan case.



EEC ARCHITECTURE

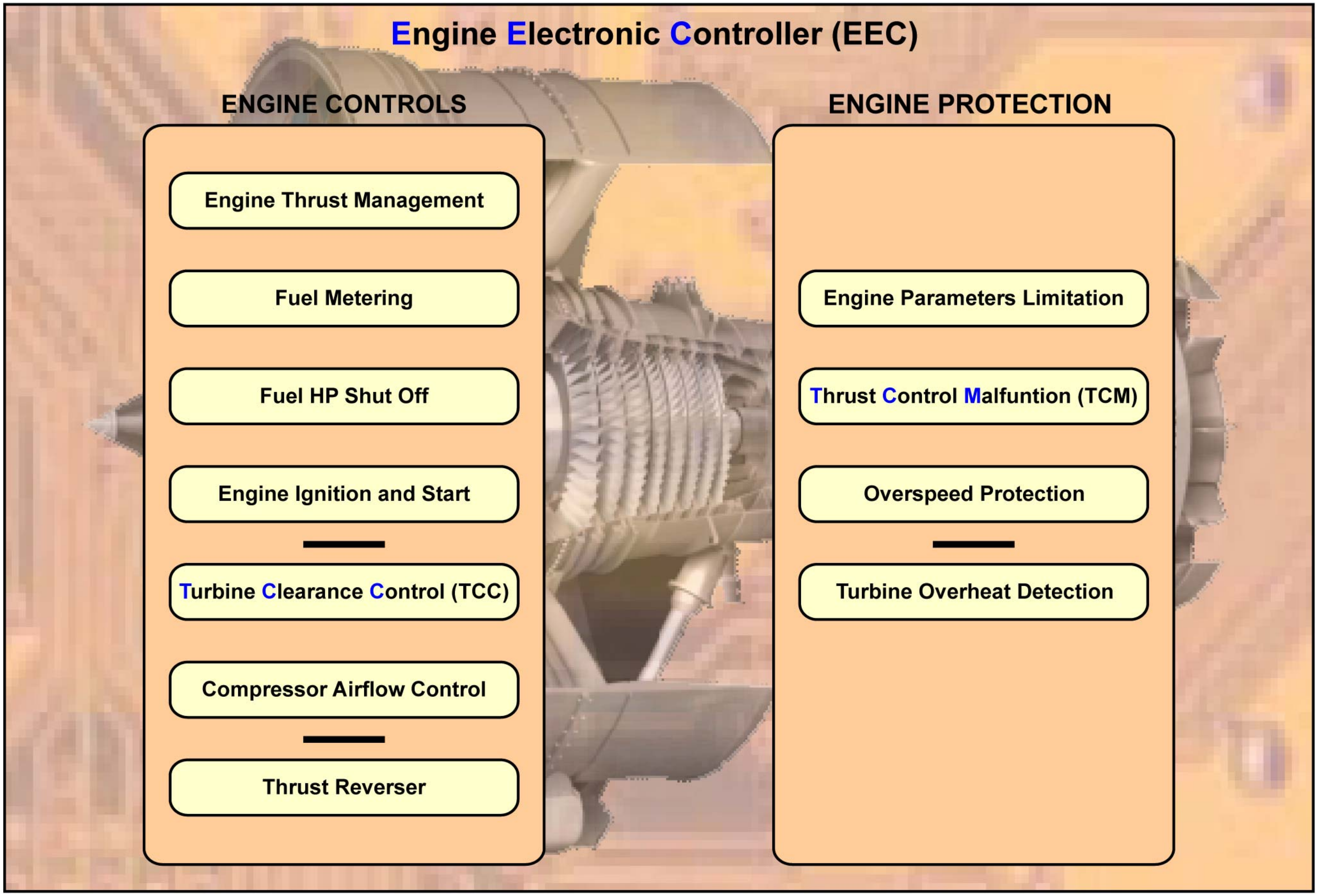
FADEC & EIPM PRESENTATION (1)

EEC Architecture (continued)

EEC Main Functions

The EEC system supplies full authority of engine control to achieve starting, shut down, steady state and transient engine operations.
The EEC main control functions are:
- Engine thrust management (Manual and auto thrust modes),
- Fuel metering through Hydro Mechanical Unit (HMU),
- Fuel HP Shut Off,
- Engine start in automatic mode with auto start abort capability,
- Engine start in manual mode,
- Continuous relight,
- Turbine Tip Clearance Control by case cooling,
- Compressor airflow control, as anti-surge devices, by means of Handling Bleed Valves and Variable Stator Vanes,
- Thrust reverser control through Electrical Thrust Reverser Actuation Controller (ETRAC).

The EEC main protection functions are:
- Engine N1, N2, N3 speeds limitation,
- EGT limitation during autostart,
- Thrust control malfunction which protects the engine when the actual thrust differs from the commanded thrust,
- LP turbine and rotors overspeed,
- IP turbine overheat detection, cockpit warning activation.



EEC ARCHITECTURE - EEC MAIN FUNCTIONS

FADEC & EIPM PRESENTATION (1)

FADEC Interfaces

The following types of signals between the FADEC systems and the Aircraft are:
- Analogue,
- Discrete signals,
- Electrical Power supply lines (28VDC and 115VAC),
- Avionics Full Duplex Switched Ethernet (AFDX) digital busses.

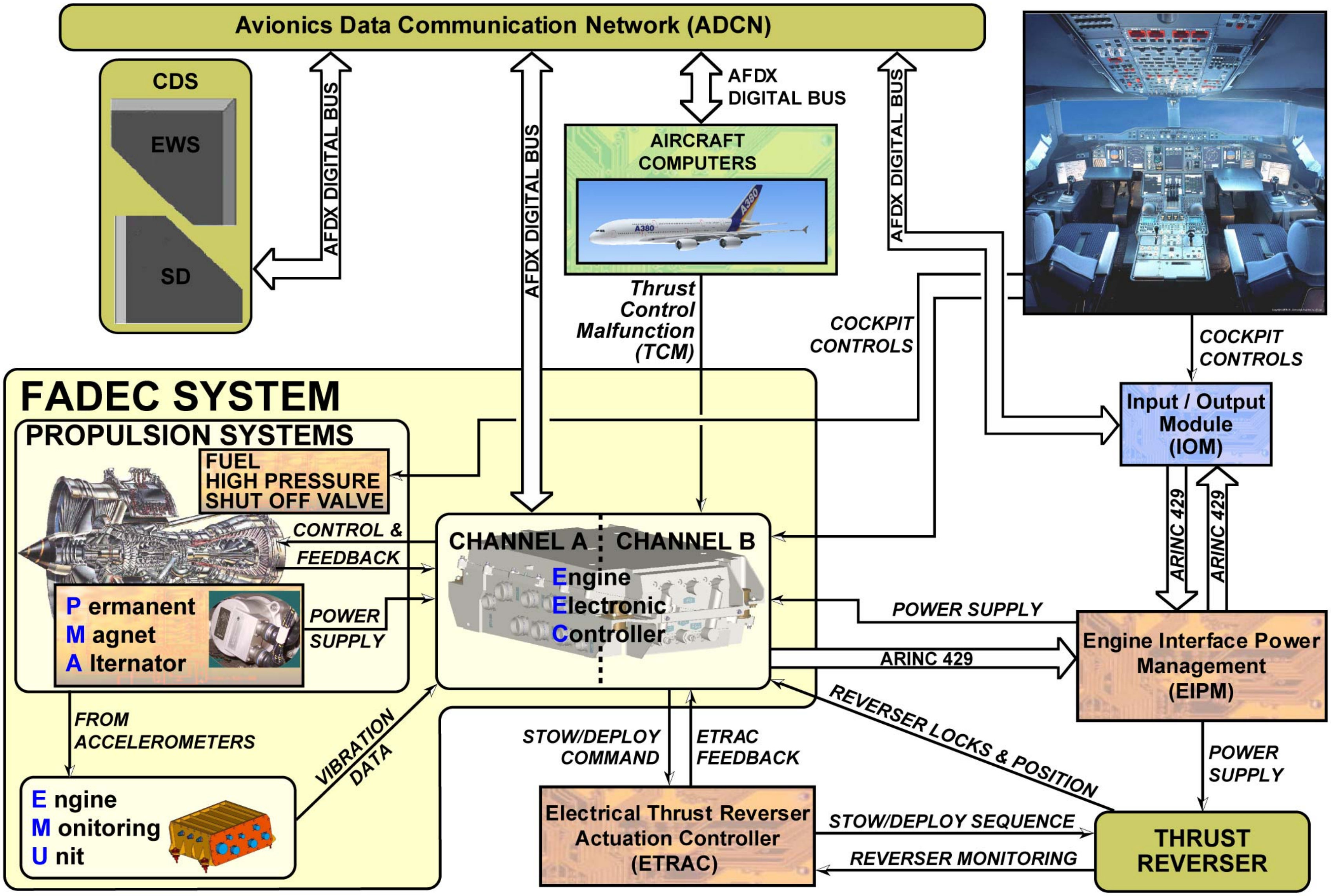
The FADEC system is connected to the Avionics Data Communication Network (ADCN).

FADEC Interface With Aircraft Computers

The interface between the FADEC system and the Aircraft is made through several aircraft computers.
In order to protect the engine against Thrust Control Malfunction (TCM), an independent signal from the aircraft is directly hardwired to each EEC. The function of this independent input is to authorize the EEC to shut down the engine if it detects an uncommanded thrust setting. The EEC digitally interfaces with ETRAS (Electrical Thrust Reverser Actuation System) to control the position of the reverser sleeves.

FADEC Cockpit Display And Warning

The following Aircraft Systems receive engine data from the EEC through the aircraft network:
-To Flight Warning System (FWS): For ECAM warnings activation.
-To Command and Displays Systems (CDS): For Engine parameters displays.



FADEC INTERFACES - FADEC INTERFACE WITH AIRCRAFT COMPUTERS & FADEC COCKPIT DISPLAY AND WARNING

FADEC & EIPM PRESENTATION (1)

The Engine Monitoring Unit

The Engine Monitoring Unit (EMU) is installed on the fan case of the engine. The Engine Monitoring Unit (EMU) functions are:
- Engine Condition Monitoring,
- Engine Vibration Monitoring and Reporting,
- Fan Out of Balance Monitoring and trimming,
- EMU Reprogramming,
- EMU Fault Accommodation,
- Engine Oil Chip Detection and,
- BITE.

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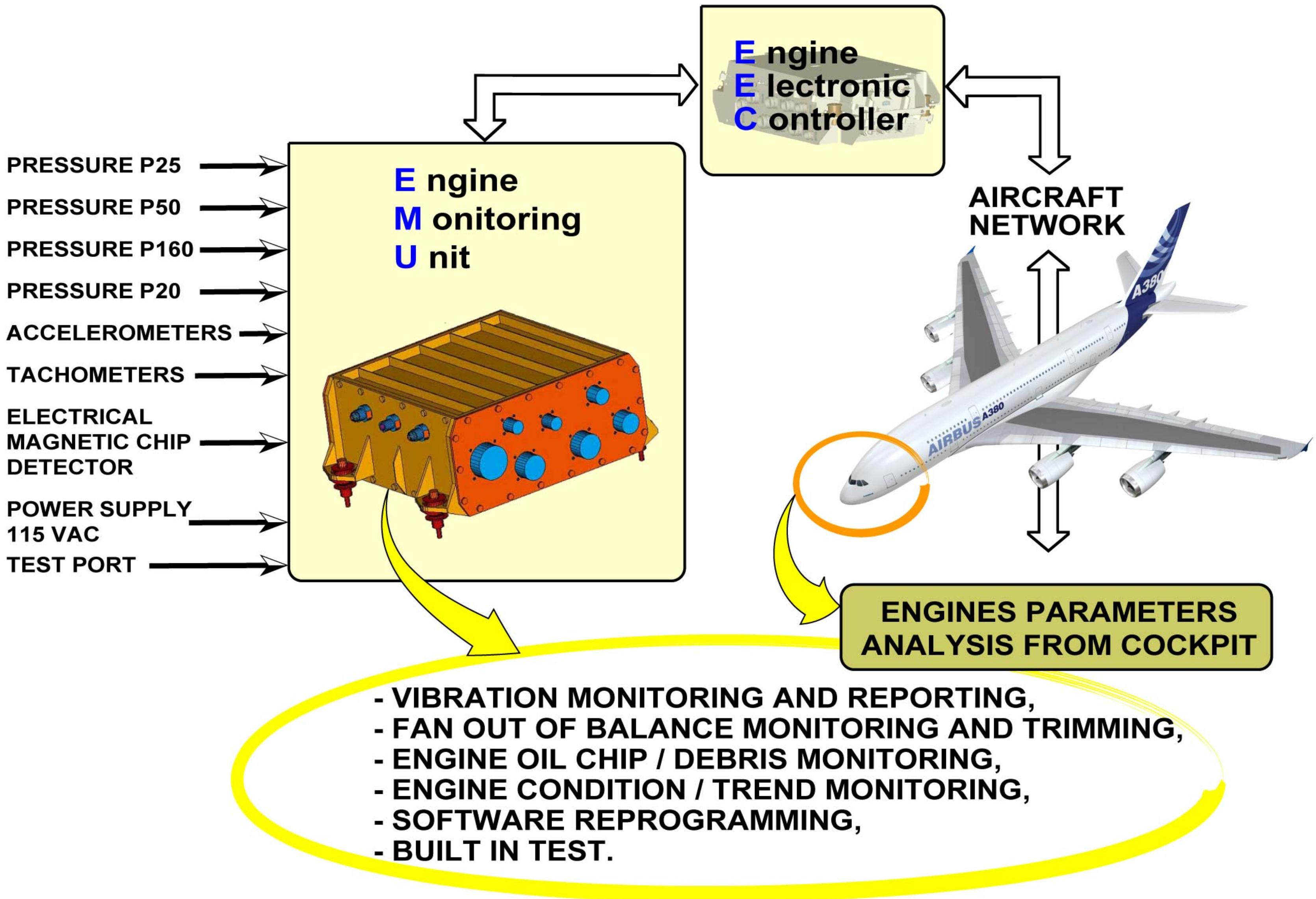
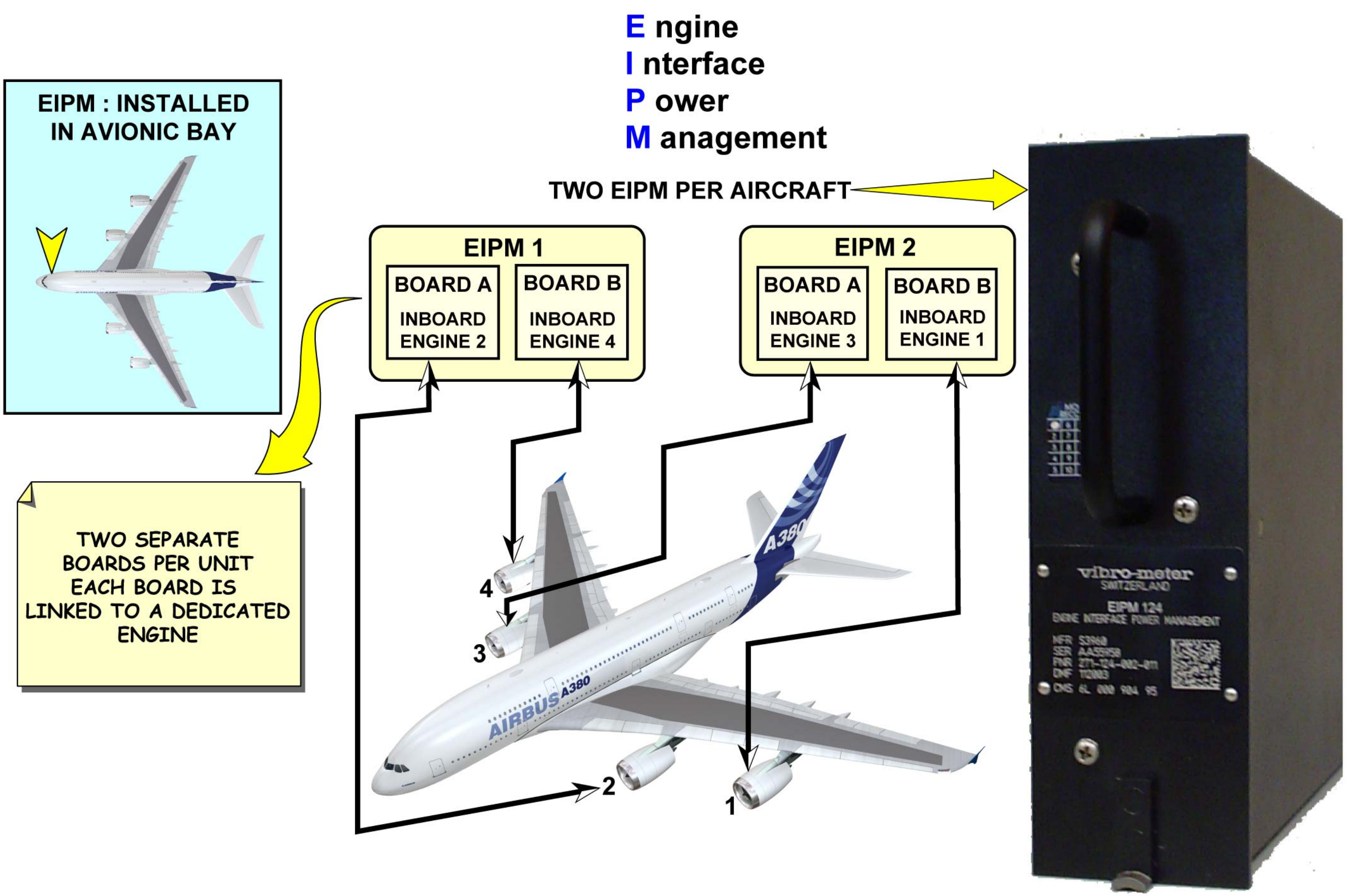


THE ENGINE MONITORING UNIT

FADEC & EIPM PRESENTATION (1)

EIPM Design

Each board gives electrical power supply, control and monitoring.
The EIPM is designed to maintain the electrical power supply to the EEC and to the ignition systems by default even if the EIPM fault occurs.

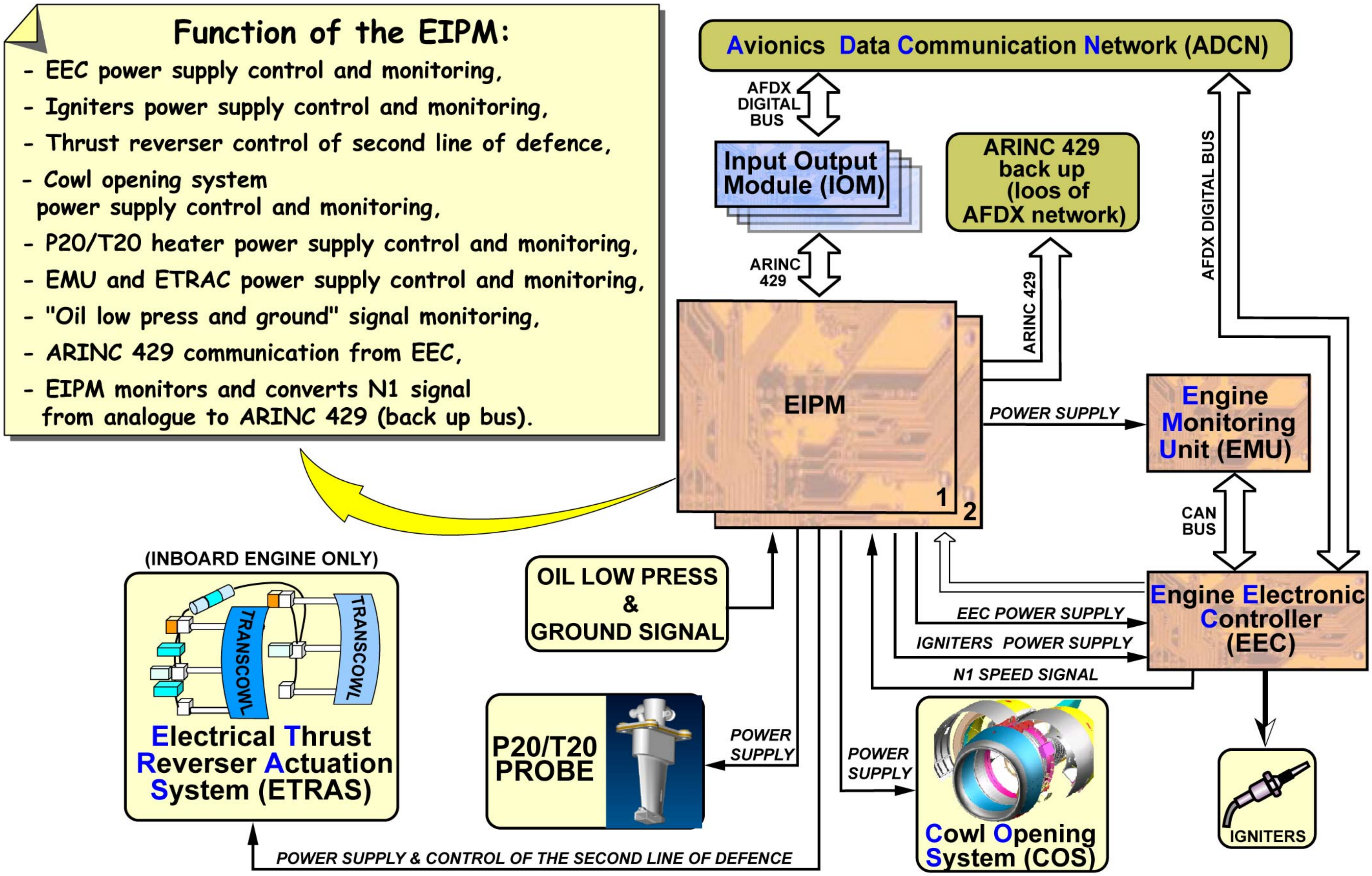

Engine
Interface
Power
Management
TWO EIPM PER AIRCRAFT
EIPM : INSTALLED IN AVIONIC BAY
EIPM 1
BOARD A
INBOARD ENGINE 2
BOARD B
INBOARD ENGINE 4
EIPM 2
BOARD A
INBOARD ENGINE 3
BOARD B
INBOARD ENGINE 1
TWO SEPARATE BOARDS PER UNIT EACH BOARD IS LINKED TO A DEDICATED ENGINE
1
2
3
4
AIRBUS A380
vibro-meter
SWITZERLAND
EIPM 124
ENGINE INTERFACE POWER MANAGEMENT

EIPM DESIGN

FADEC & EIPM PRESENTATION (1)

EIPM Function

Functions of the EIPM are described below.
-Power the EEC when at least one of the following conditions is true:
Master Lever of related engine is ON.
Rotary Selector is in IGN/START or CRANK position.
FADEC Ground Power Push-button of the related engine is entered:
-Igniters power supply control and monitoring,
-Thrust reverser control of second line of defense. The EIPM commands the thrust reverser second line of defense by controlling the supplying power to the ETRAC (115VAC), on the inboard engine only.
- Cowl opening system power supply control and monitoring,
- P20T20 heater power supply control and monitoring,
- EMU and ETRAC power supply control and monitoring,
- "Oil low press and ground" signal monitoring,
- ARINC 429 communication with EEC,
- EIPM monitors and converts N1 signal from analogue to ARINC 429, as an N1 speed back-up signal. The analog signal is wired directly to the EIPM computer. The N1 speed value is then forwarded to the IOM and to the Flight Warning System.
- An ARINC 429 Output bus is connected to the EIPM. This bus is used as back up for cockpit display in case of total loss of AFDX Network.



EIPM FUNCTION

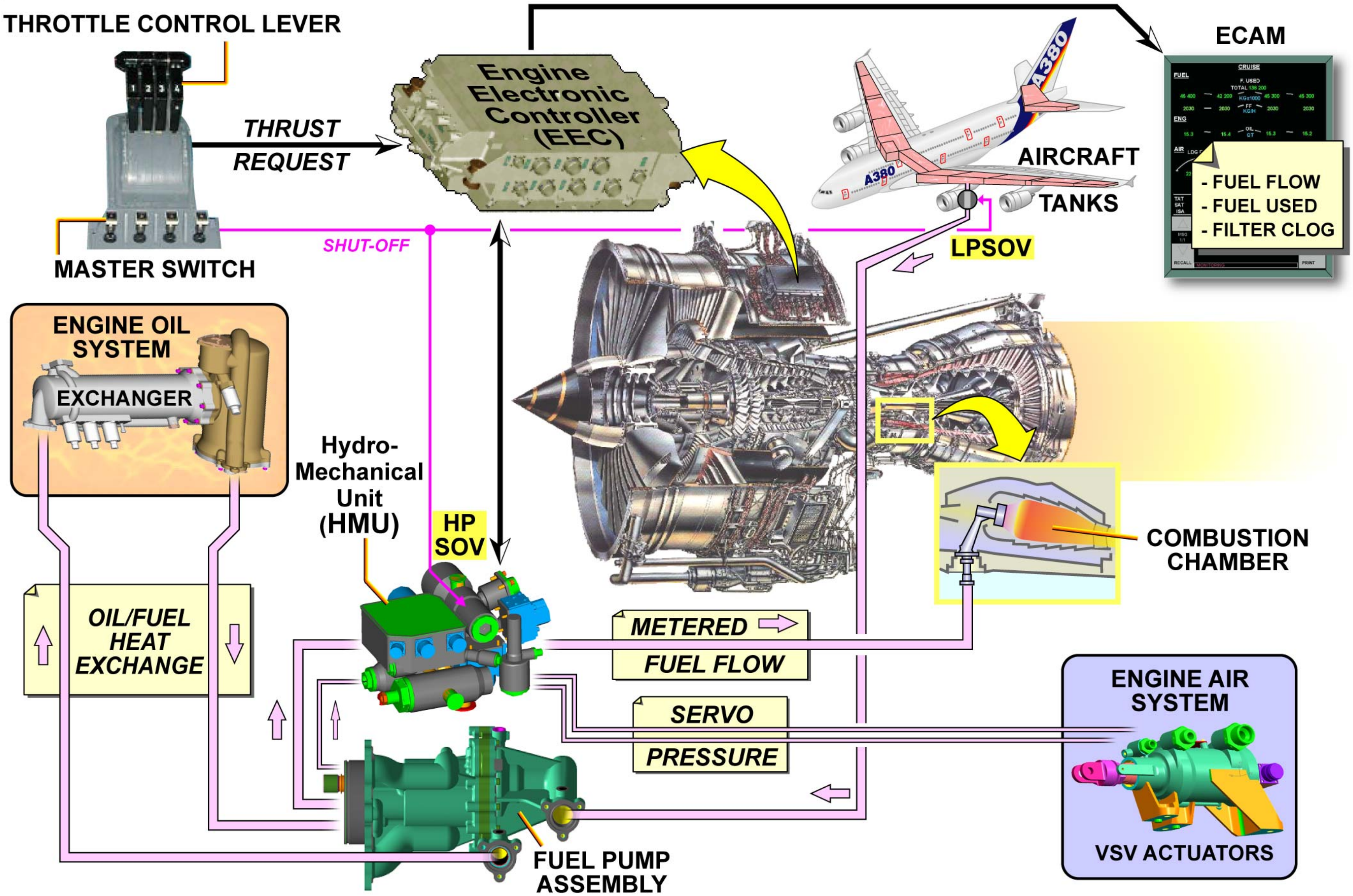
ENGINE FUEL SYSTEM PRESENTATION (1)

General

The engine fuel system is designed to supply metered fuel to the combustion chamber to achieve the requested engine thrust.
In addition the fuel is used to exchange heat with the engine oil.
The fuel is also used as servo pressure to operate actuators of the engine air system.
The Hydro Mechanical Unit (HMU) and the fuel pump assembly are the main components of the engine fuel system.
The fuel pump assembly houses 3 pumps. Each pumps feeds a specific circuit of the fuel system.
The Engine Electronic Controller (EEC) manages the fuel system through the HMU following the thrust request from the cockpit.
The EEC also sends data to the ECAM to monitor the fuel system.

Low Pressure & High Pressure Fuel Shut-Off

The LP Shut-Off Valve is installed at the exit of the aircraft tank and the HP Shut-Off Valve is installed inside the HMU.
Engine shut down is done by setting the MASTER switch OFF, which closes the LP Shut Off valve and the HP Shut Off Valve directly.
The EEC can also close the HP Shut Off Valve automatically in case of aborted start sequence on ground.



GENERAL - LOW PRESSURE & HIGH PRESSURE FUEL SHUT-OFF

IGNITION & STARTING PRESENTATION (1)

General

The ignition and starting systems are used for ground or in-flight starting and to crank the engine.
The EEC is able to make an automatic and manual engine starts, they are initiated from the cockpit controls.
The EEC controls the following sequences:
− Automatic engine ground starting,
− Manual engine ground starting,
− Engine crank,
− in flight starting,
− Continuous ignition,
− Auto relight function.
The ignition and starting systems use pneumatic power to drive the HP rotor and produce electrical sparks to ignite the fuel / air mixture in the combustion chamber.
The EEC gives the Ignition and Starting indications to the ECAM System Display (SD).

Starting System

The starting system includes:
- Pneumatic starter air duct,
- Starter Control Valve (SCV),
- Pneumatic starter.
The system uses pressurized air to drive an air turbine starter at high speed. The starter drives the engine High Pressure (HP) rotor through a reduction gear and the engine accessory drive system. The air, which is necessary to drive the starter, comes from one of the following three sources:
- Auxiliary Power Unit (APU) bleed air supply,
- Another engine cross bleed air supply,
- External Ground HP air supply.

The Starter Control Valve is a butterfly type valve. It is electrically controlled and pneumatically operated.
The SCV is controlled open and closed by the EEC, during start or crank sequences.
The SCV is located on the lower right side part of the Low Pressure (LP) compressor case.
In case of failure, the SCV can be manually operated through a manual override.

Ignition System

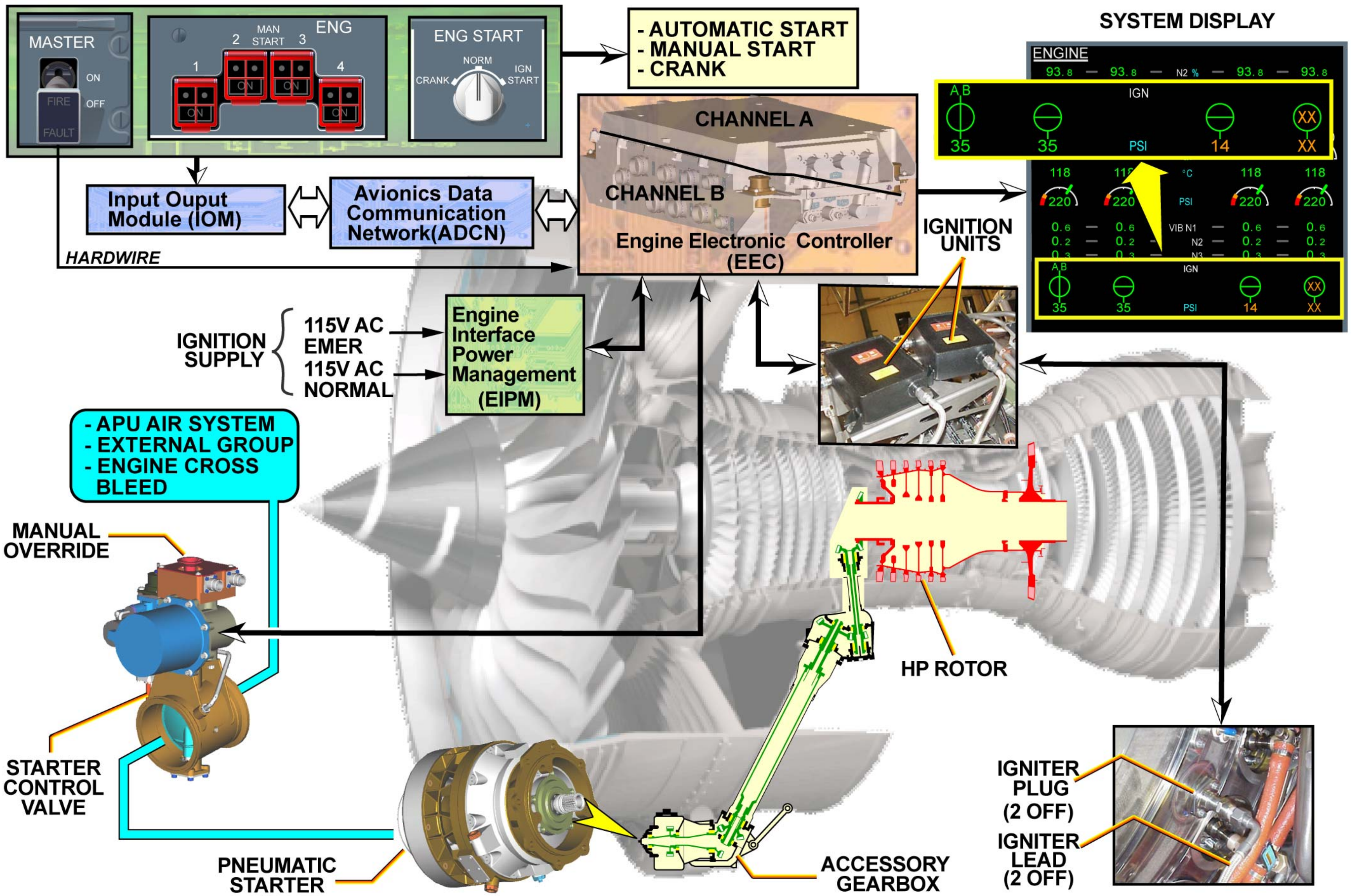
Each engine has two ignition systems.
Each ignition system includes:
- One ignition unit,
- One ignition lead,
- One igniter plug.
Each ignition system can operate together or independently.
Each system has an ignition power supply and an ignition distribution system.
The EEC alternates between the "A" and "B" ignition system for automatic engine ground start.
Each EEC channel controls and monitors the supply of electrical power to each ignition unit.
The EEC is supplied with 115VAC from Aircraft Emergency and Normal busses through the EIPM.

Indicating

During the Starting or Cranking sequence the NACelle temperature indication is replaced automatically by the IGNition and Start parameters on the System Display (SD) ENGINE page.
For each engine the following indications are displayed:
- The ignition system selected by EEC (IGN A and/or B),
- The bleed pressure value available (PSI) and,

- The Starter Control Valve position (in line when open or not in line when closed).

The EEC also supplies fault annunciation to the Flight Warning System (FWS).



GENERAL ... INDICATING

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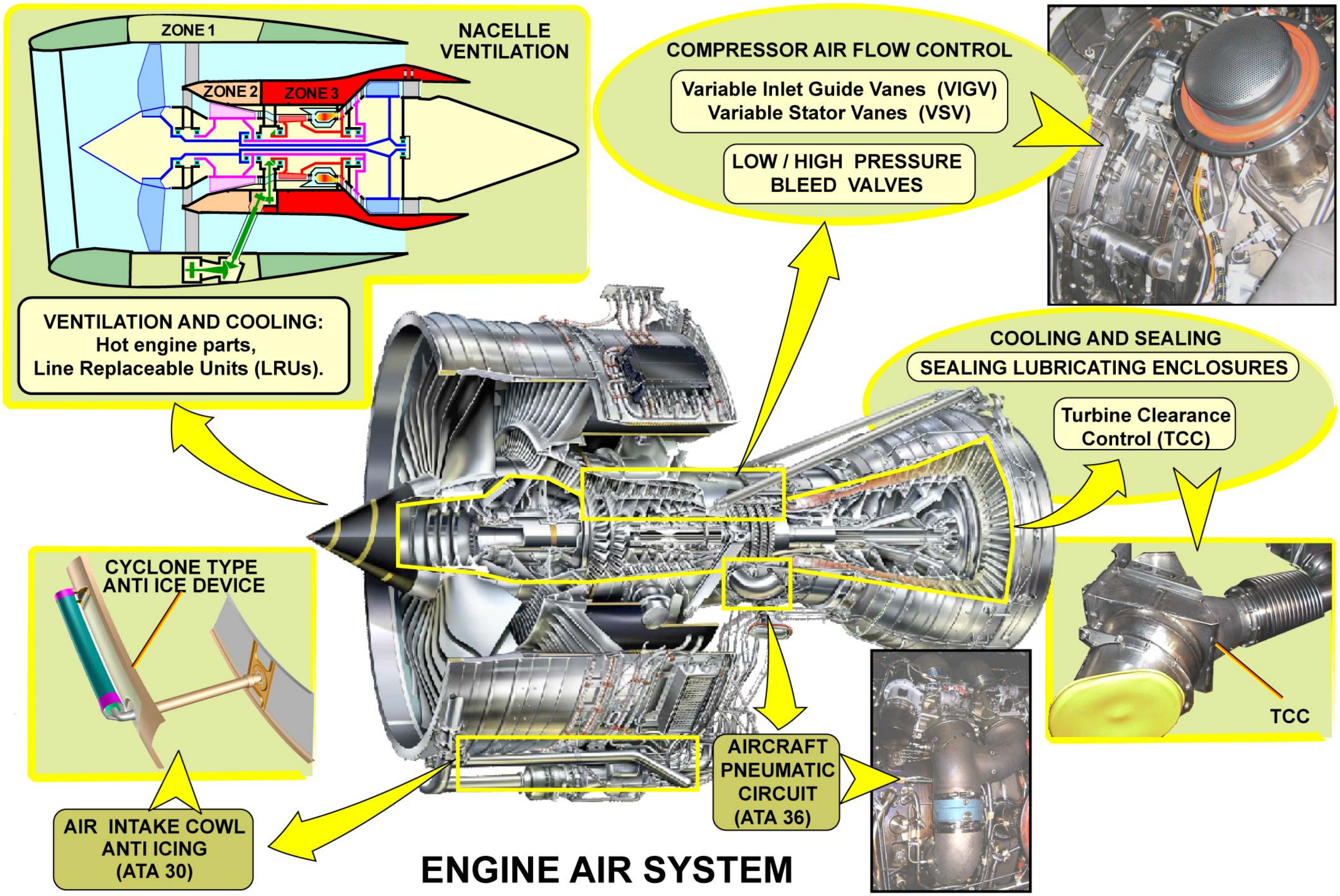
ENGINE AIR SYSTEM PRESENTATION (1)

General

Engine air is tapped from the engine compressor and the nacelle, it includes of the following subsystems:
-Nacelle ventilation and cooling of parts subjected to high thermal stresses,
-Cooling of the internal hot engine parts and Sealing of the lubricating enclosures,
-Compressor airflow control using bleed valves and variable inlet guide vanes and variable stator vanes (VIGV,VSVs),
-Supplying air for the aircraft pneumatic circuit (ATA36),
-Supplying air for the intake cowl anti icing device (ATA 30).


ZONE 1
ZONE 2
ZONE 3
NACELLE VENTILATION
VENTILATION AND COOLING:
Hot engine parts,
Line Replaceable Units (LRUs).
COMPRESSOR AIR FLOW CONTROL
Variable Inlet Guide Vanes (VIGV)
Variable Stator Vanes (VSV)
LOW / HIGH PRESSURE BLEED VALVES
COOLING AND SEALING
SEALING LUBRICATING ENCLOSURES
Turbine Clearance Control (TCC)
TCC
CYCLONE TYPE ANTI ICE DEVICE
AIR INTAKE COWL ANTI ICING (ATA 30)
AIRCRAFT PNEUMATIC CIRCUIT (ATA 36)
ENGINE AIR SYSTEM

GENERAL

ENGINE AIR SYSTEM PRESENTATION (1)

Nacelle Ventilation

The power plant includes three ventilated zones.
The function of the zones ventilation system is:
-To supply cooling for the components and the parts installed on the engine,
-To keep nacelle temperature at satisfactory levels,
-To isolate areas of the engine for better fire protection.
Zone 1: Is the annular space between the Low Pressure (LP) compressor case and the fan cowl doors.
Zone 2: Is the annular space between the Intermediate Pressure (IP) compressor case and the gas generator fairings.
Zone 3: Is the annular space between the core engine and the inner fixed structure of the fixed fan exhaust cowls.

Zone 1 - Fan Case Ventilation

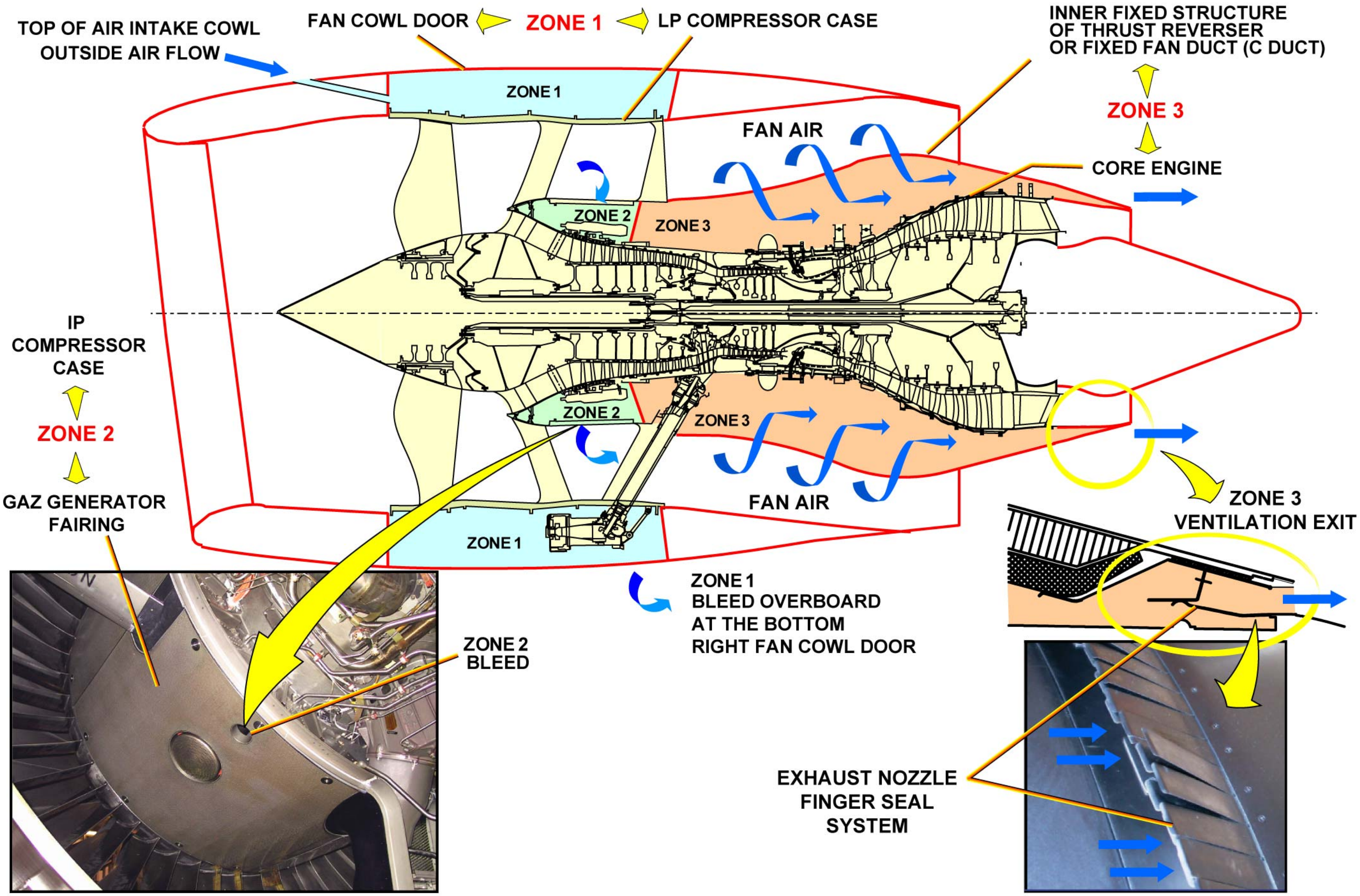
The primary function of the zone 1 ventilation is to prevent fire and to maintain the Line Replaceable Units (LRUs) for the fuel, oil, hydraulic and FADEC systems at a satisfactory temperature level.
An inlet at the top of the air intake cowl supplies the zone 1 with airflow. An outlet at the bottom of the right fan cowl door exhausts the air overboard.

Zone 2 - Intermediate Compressor Case Compartment

The primary function of the zone 2 ventilation is to prevent fire and to keep the engine components at a satisfactory temperature.
Air from the LP compressor flows through two front inlets in the top gas generator fairings. At the bottom, two rear outlets in the gas generator fairings bleeds back the air into the LP airflow.

Zone 3 - Engine Core Compartment

Zone 3 is a hot area; the primary function of the zone 3 ventilation is to keep engine components at a satisfactory temperature.
LP compressor air flows through openings in the inner fixed structure of the fan exhaust cowls. The air flowing around the zone cools down the components.
At the rear of the zone the air is bled overboard through an annular gap between the fan exhaust cowls after-body and the exhaust nozzle.
The nacelle temperature thermocouple is attached to a bracket at the rear of the Turbine Case Cooling (TCC).

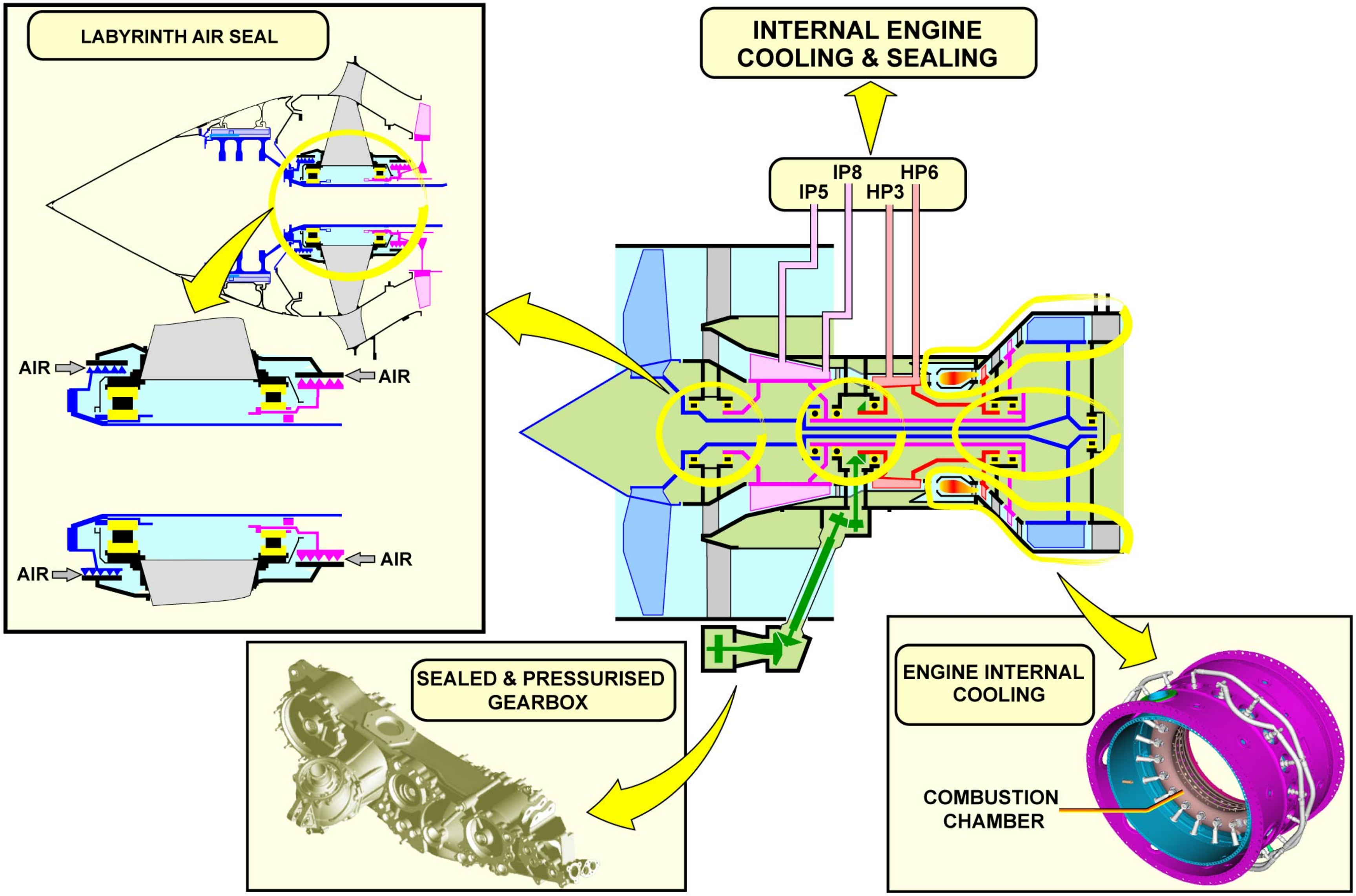


NACELLE VENTILATION - ZONE 1 - FAN CASE VENTILATION ... ZONE 3 - ENGINE CORE COMPARTMENT

ENGINE AIR SYSTEM PRESENTATION (1)

Cooling And Sealing

The engine is internally cooled and sealed (labyrinth seals) with air, which is supplied by the Intermediate Pressure (IP stages IP5 and IP8) and the High Pressure (HP stages HP3 and HP6) compressors.



COOLING AND SEALING

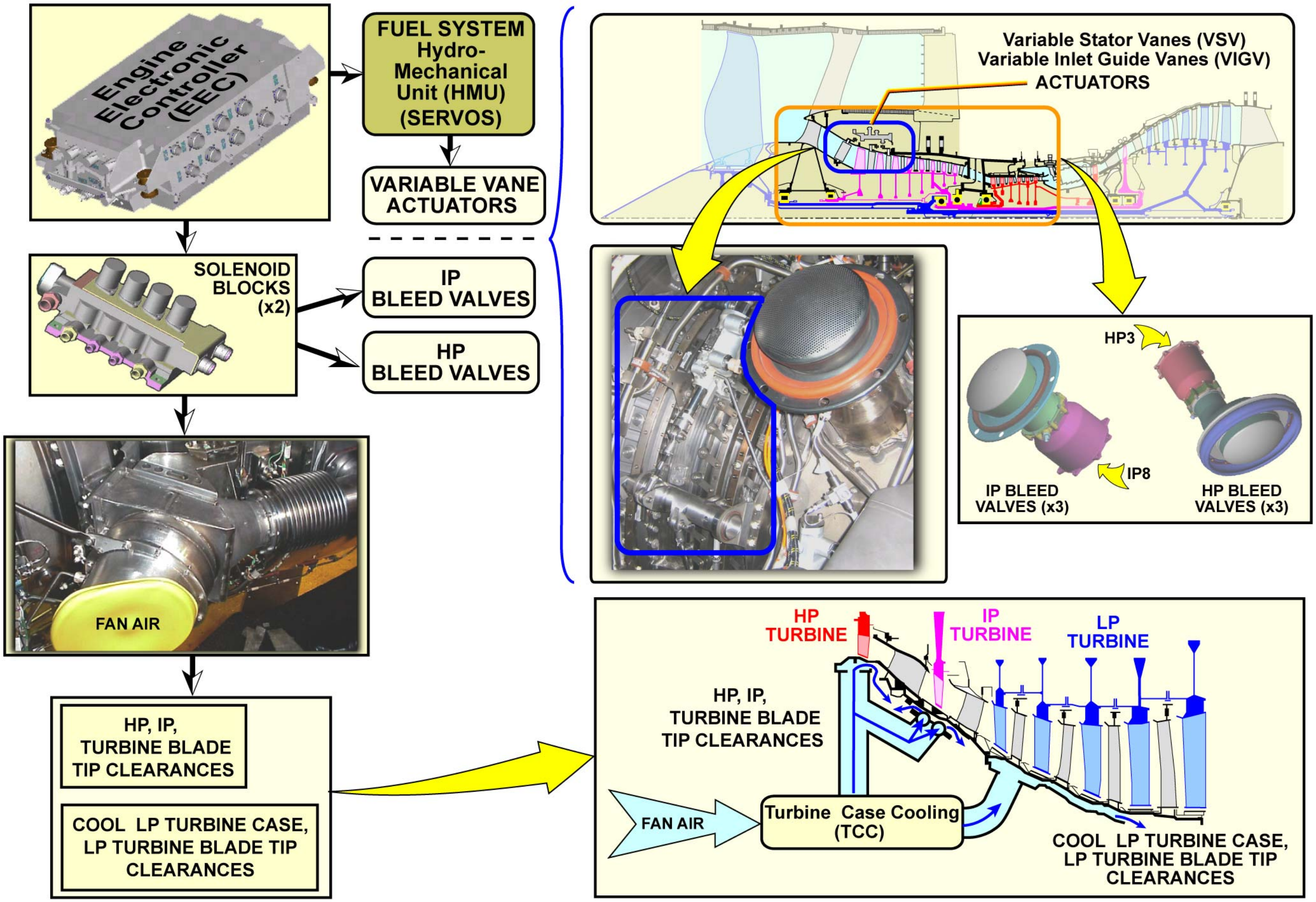
ENGINE AIR SYSTEM PRESENTATION (1)

Turbine Case Cooling (TCC)

Turbine Case Cooling (TCC) system is used to cool the LP turbine case and controls HP, IP and LP turbine blades tip clearances, in order to increase the engine efficiency. The air for the TCC system is the LP compressor flow (fan air).
The EEC controls the operation of the TCC valve.

IP/HP Compressor Airflow

The EEC controls the airflow system, and is composed of:
-Three IP bleed valves in line with stage 8 of the IP compressor,
-Three HP bleed valves in line with stage 3 of the HP compressor.
-One stage of IP compressor Variable Inlet Guide Vanes (VIGVs),
-Two stages of IP compressor Variable Stator Vanes (VSVs),
Both bleed valves and variable vanes are used to protect the engine against surge and stall.



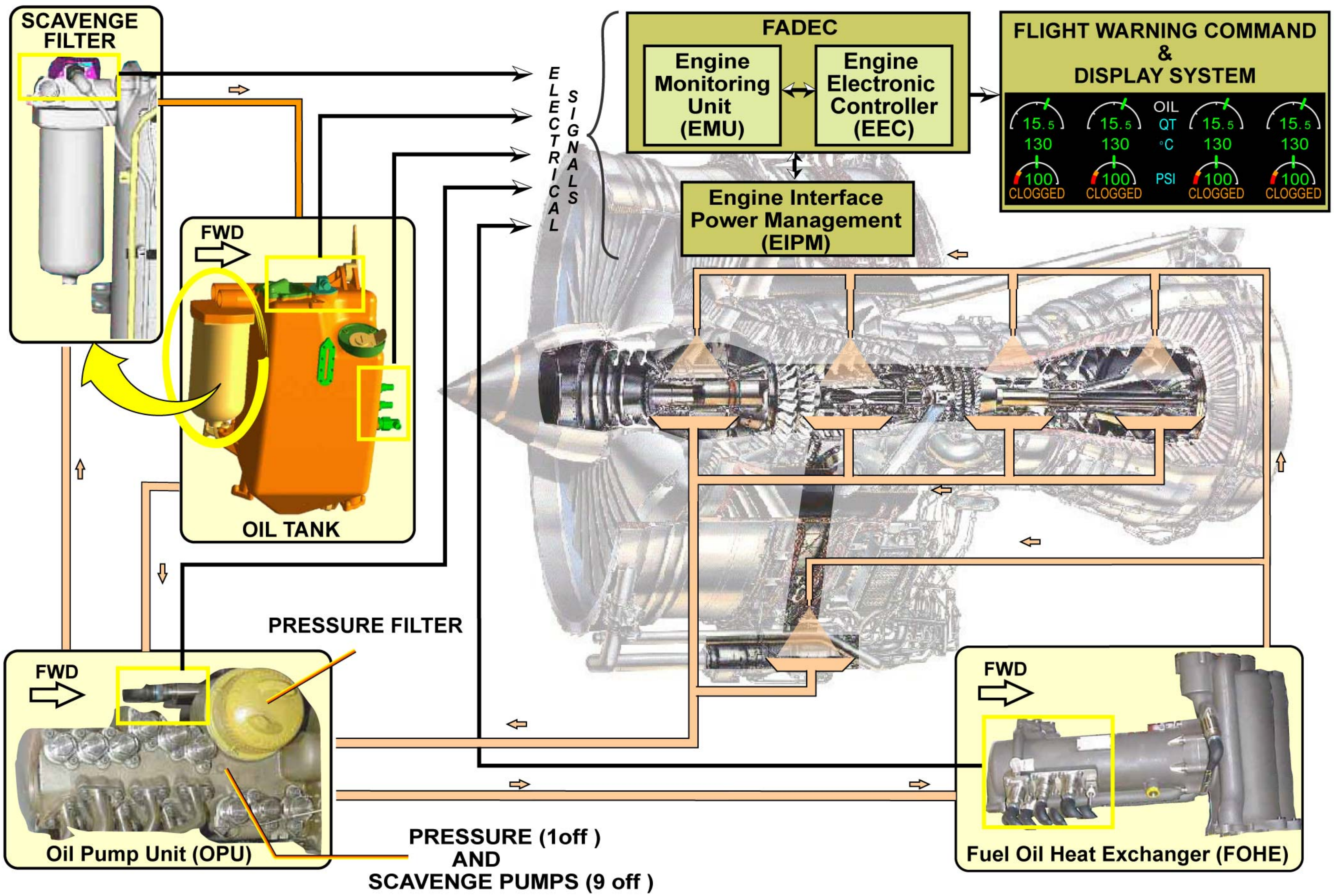
TURBINE CASE COOLING (TCC) & IP/HP COMPRESSOR AIRFLOW

ENGINE OIL SYSTEM PRESENTATION (1)

General

The engine oil system supplies clean oil at a correct pressure and temperature to lubricate and to cool main bearings and gearboxes. It is a recirculatory and de-aerated system. The scavenged oil is returned to the tank.
The main components of the oil circuit are:
- The oil tank,
- The Oil Pump Unit (OPU),
- The Fuel Oil Heat Exchanger (FOHE),
- The scavenge filter.

The FADEC and the Engine Interface Power Management (EIPM) monitor the main oil parameters. Then the Engine Electronic Computer (EEC) on the engine page of the flight warning command and display system transmits them.


SCAVENGE FILTER
ELECTRICAL SIGNALS
FADEC
Engine Monitoring Unit (EMU)
Engine Electronic Controller (EEC)
FLIGHT WARNING COMMAND & DISPLAY SYSTEM
OIL
QT
°C
PSI
15.5
130
100
CLOGGED
Engine Interface Power Management (EIPM)
FWD
OIL TANK
PRESSURE FILTER
FWD
Oil Pump Unit (OPU)
PRESSURE (1off) AND SCAVENGE PUMPS (9 off)
FWD
Fuel Oil Heat Exchanger (FOHE)

GENERAL

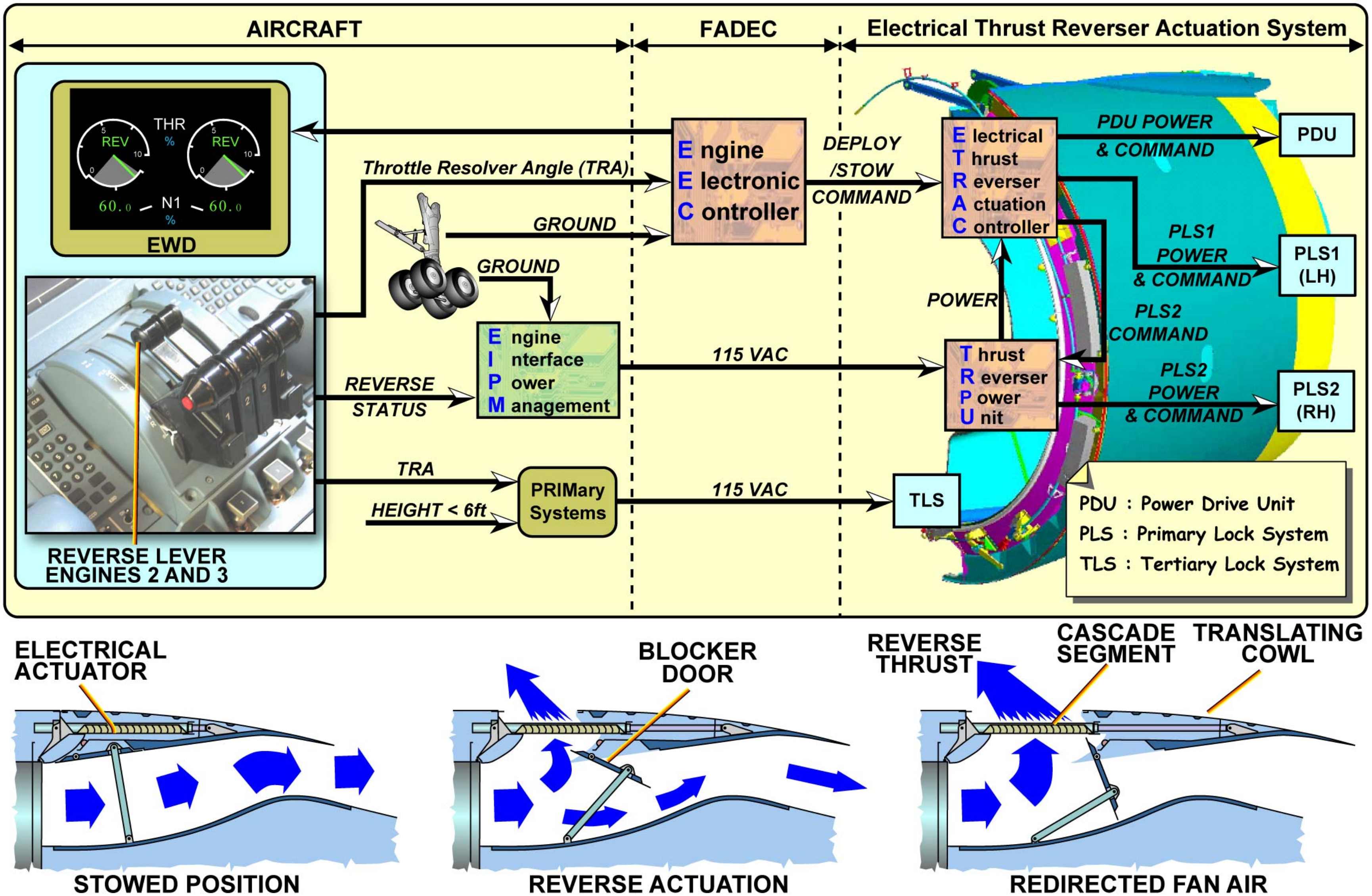
THRUST REVERSER PRESENTATION (1)

General

The thrust reverser of the A380 is an Electrical Thrust Reverser Actuation System (ETRAS). Thrust reversers are only installed on the inboard position nacelles.
The Thrust Reverser structure has two translating cowls.
In forward thrust configuration the translating cowl is in the forward, stowed position, covering the cascades and the blocker doors are faired into
the inner acoustic panel of the translating cowl.
In reverse thrust, deployed position, the translating cowl moves aft to uncover the cascades, and the blocker doors rotate inward against the fan flow duct to block the fan exhaust.

ETRAS Command Lines

The Thrust Reverser actuation power chain is made of the following components:
-Electrical Thrust Reverser Actuation Controller (ETRAC),
-Thrust Reverser Power Unit (TRPU),
-The Power Drive Unit (PDU),
-The Primary Lock Systems (PLS), LH and RH,
-The Tertiary Lock System (TLS).
The ETRAC digitally interfaces with EEC and supplies control for the position of the sleeves.
The ETRAS requires three separate aircraft commands to start the deployment (three lines of defense):
- The command to supply 115 VAC to unlock the TLS through PRIMary systems,
- The command to supply 115 VAC to the TRPU through EIPM,
- The deploy or stow command to the ETRAC through EEC.



GENERAL - ETRAS COMMAND LINES

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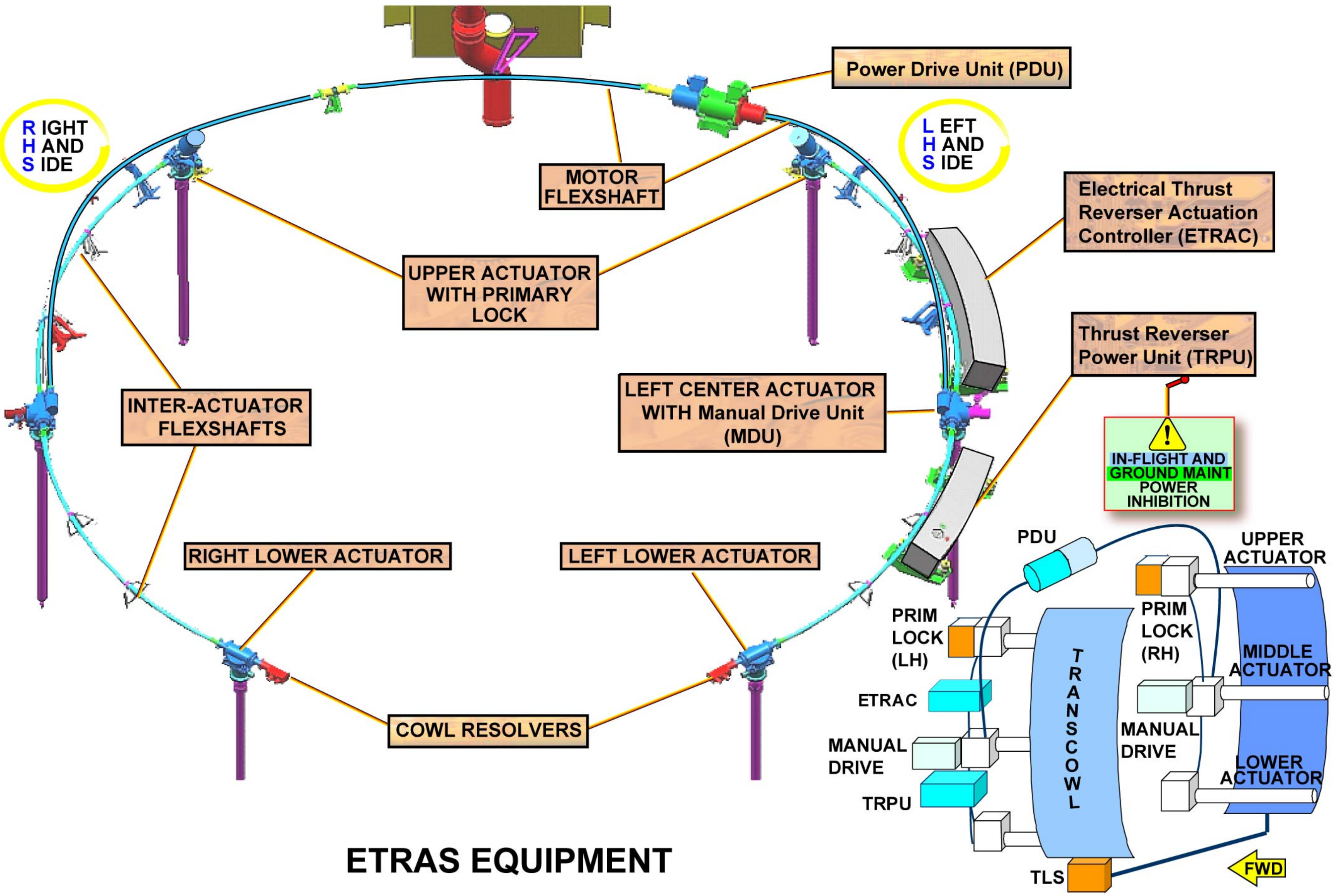
THRUST REVERSER PRESENTATION (1)

ETRAS Equipment

The Electrical Thrust Reverser Actuation System (ETRAS) deploys and stows the two mechanically linked transcowl sleeves.
The ETRAS includes:
- Electrical Thrust Reverser Actuation Controller (ETRAC),
- Thrust Reverser Power Unit (TRPU),
- Power Drive Unit (PDU) electrical motor,
- Flexshafts,
- Actuators (2 lowers, 2 centers, 2 uppers),
- Primary Locks (integrated to upper actuators),
- Manual Drive Units (integrated to middle actuators),
Tertiary Lock System (TLS),
- Electrical Harnesses (Power and control/monitoring).
The thrust reverser is locked by mechanical means inside the upper actuators named Primary Lock System (PLS) and supplemented by an electrical Tertiary Locking System (TLS).
The ETRAS has an inhibition lever on the TRPU to deactivate the system for maintenance.



ETRAS EQUIPMENT

POWER PLANT DRAIN PRESENTATION (1)

General

The power plant drains collect and discard from the pylon, nacelle and engine, all the unwanted liquids to avoid fire and fluid accumulation.
These fluids are fuel, hydraulic fluid, oil and water.
The power plant drains also supply an help to accurate trouble shooting.

Pylon Drains

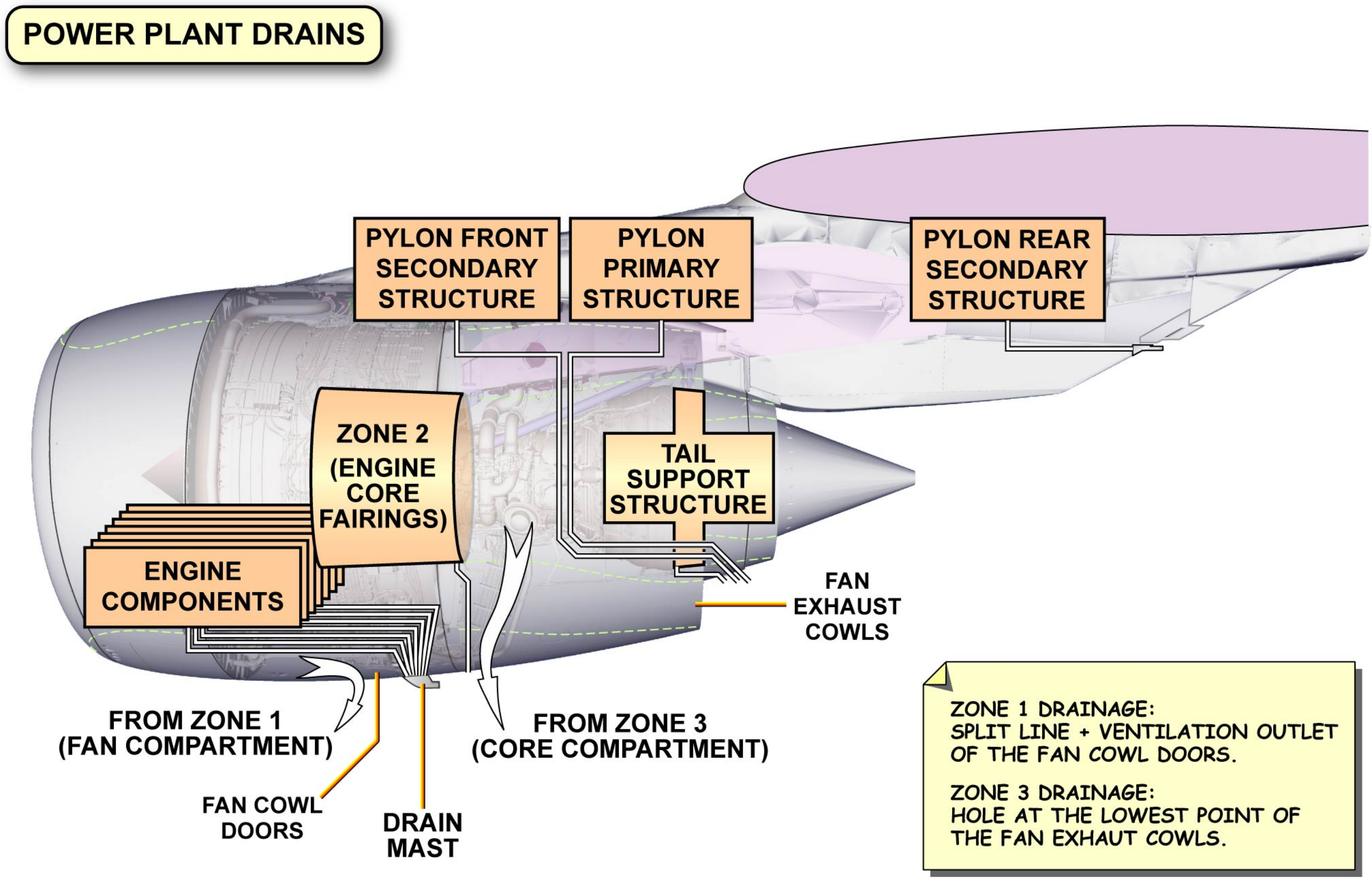
The primary, the front secondary and the rear secondary structures of the pylon are separately drained.
The drains, of the primary and front secondary structures of the pylon, exit at the split line of fan exhaust cowl rear part.
The drains of the pylon rear secondary structure directly exit through pylon trailing edge.

Nacelle Drains

Drained nacelle areas are the zone 1 and the zone 3. The Zone 2 is an engine area.
The zone 1 of the nacelle is also called fan compartment and the zone 3 of the nacelle is also called core compartment,
The zone 1 is drained through both the split line and the ventilation outlet of the fan cowl doors.
The zone 3 is drained though a hole located at the lowest point of the fan exhaust cowls.

Engine Drains

Zone 2 is enclosed by the engine core fairings. The drain of the zone 2 exits at the split line of the fan exhaust cowl front part.
The drain of the tail support structure exits at the split line of the fan exhaust cowl rear part, just in front of the 2 pylon drains. This drain discards any residual fuel after an aborted start or a wet crank.
The other engine components are drained through the drain mast.



GENERAL - PYLON DRAINS ... ENGINE DRAINS

POWER PLANT DRAIN PRESENTATION (1)

Drain Mast

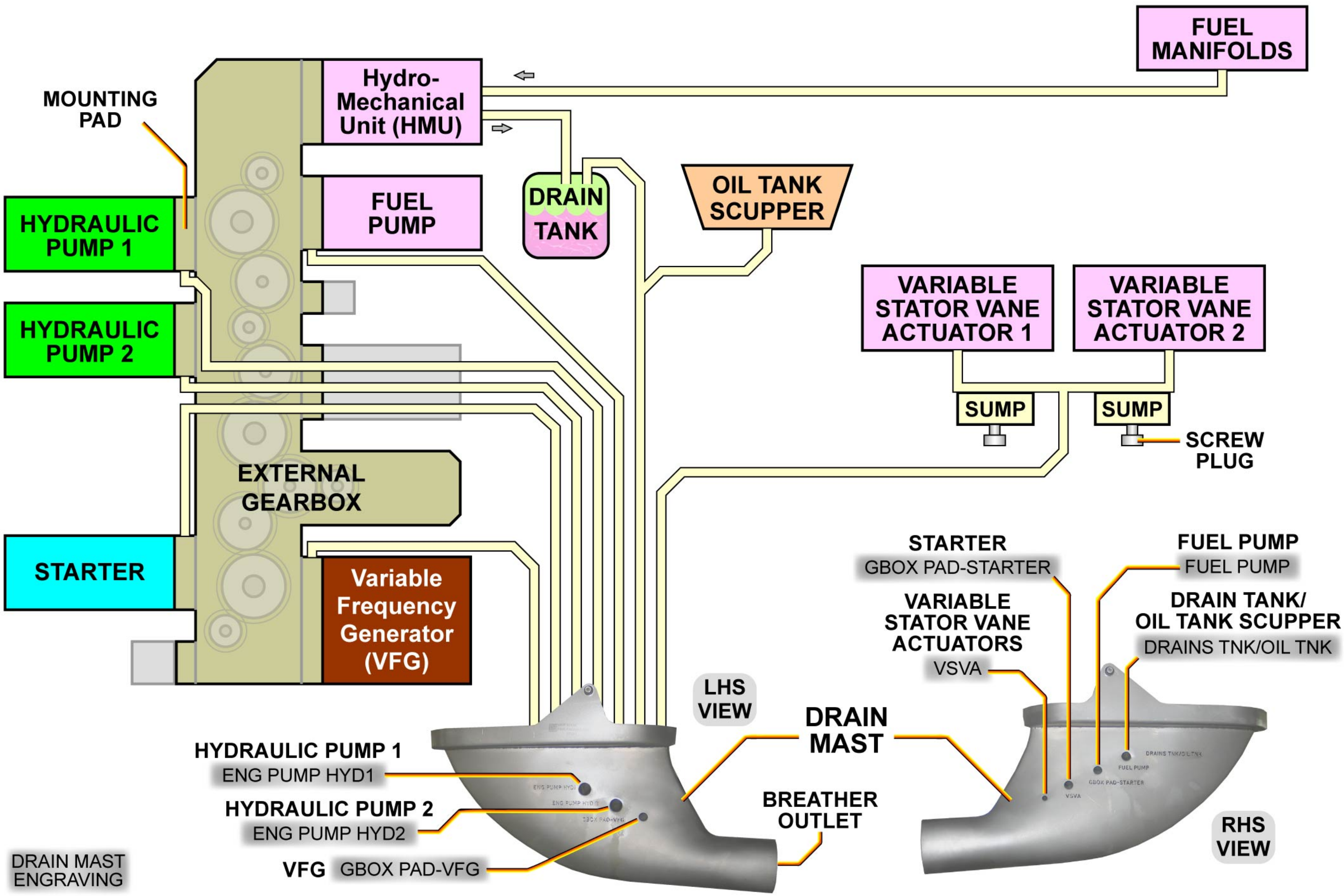
The drain mast has an aerodynamic shape and it is installed at the rear face of the external gearbox.
It protrudes the nacelle at the bottom split line between the 2 fan cowl doors.
The drain mast is connected from the drained components via separate lines. Each line has its dedicated outlet located on one side of the drain mast. The name of the corresponding drained component is engraved beside its outlet, if an outlet becomes wet, the leaking component is easily identified.
Note that the drain mast includes a breather outlet to vent the engine oil system.

Drain Mast Connections

The drained components, which are installed on the external gearbox, are connected to the drain mast through their mounting pads.
These components are:
- Hydraulic pump 1,
- Hydraulic pump 2,
- Starter,
- Fuel pump and,
- Variable Frequency Generator (VFG).

The drain lines of the 2 Variable Stator Vane Actuators are grouped together. However if the identification of the leaking unit is required, 2 sumps with screw plugs are installed on the pipes before the junction.
The drain tank collects the fuel from the manifolds at engine shutdown or in case of aborted start. At each engine start the content of the drain tank is drawn back in the engine fuel system. After aborted starts if the drain tank becomes full, the surplus is discarded through the drain mast.
The oil tank scupper collects and drains the oil that could be spilled during a servicing.

Note that the drain lines of the drain tank and the oil tank scupper are grouped together.

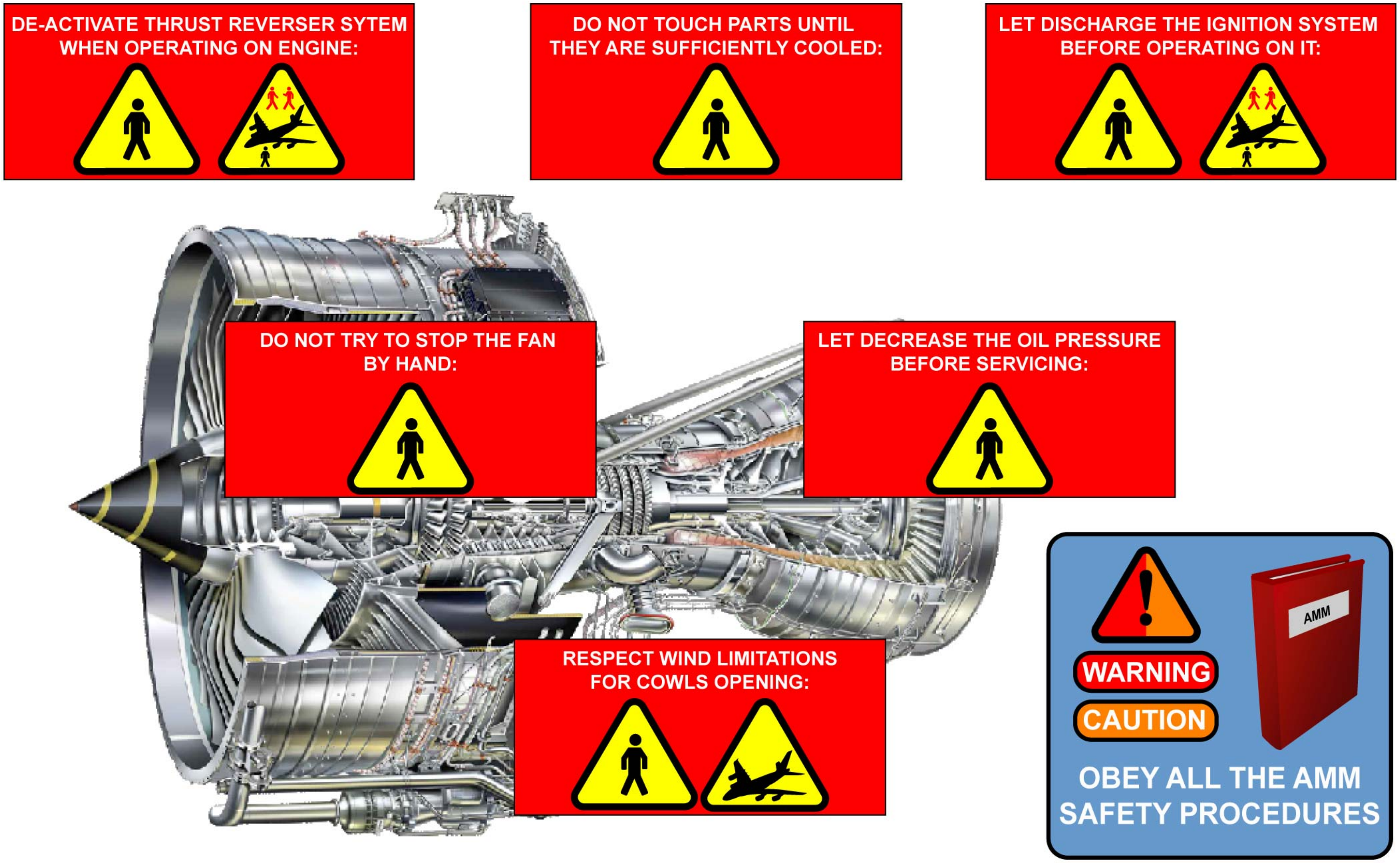


DRAIN MAST - DRAIN MAST CONNECTIONS

ENGINE MAINTENANCE (1)

Engine Safety Items

Here is an overview of main safety precautions relative to the engines.
For maintenance tasks, deactivate the thrust reverser before working around it, put the safety devices and the warning notices in position. Otherwise the thrust reverser can operate accidentally.
Make sure that all engine areas are as clear as possible and that the proper fire fighting equipment is in place.
Do not try to stop fan by hand.
To open the engine cowls, respect the wind limitations and the given opening/closing sequence.
After the engine shutdown, parts can stay hot for almost one hour.
Let the pressure decrease in the oil tank before doing the oil servicing to prevent hot engine oil splashes.
Let discharge the ignition system since it uses high energy. Keep in mind that this system may be energized through tests.
The engine fuel and oil are poisonous. If you spray oil or fuel on your skin wash yourself.



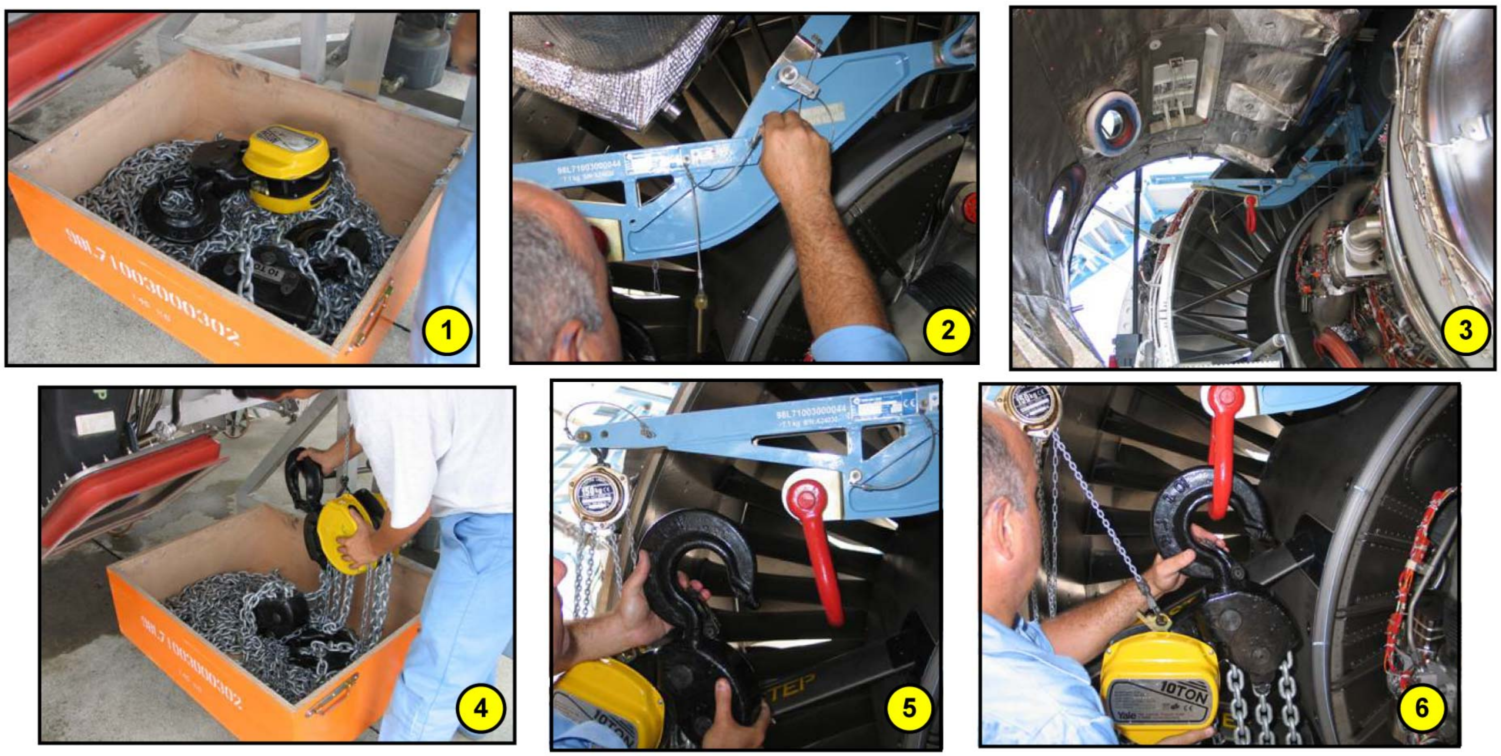
ENGINE SAFETY ITEMS

ENGINE MAINTENANCE (1)

Engine Ground Support Equipment

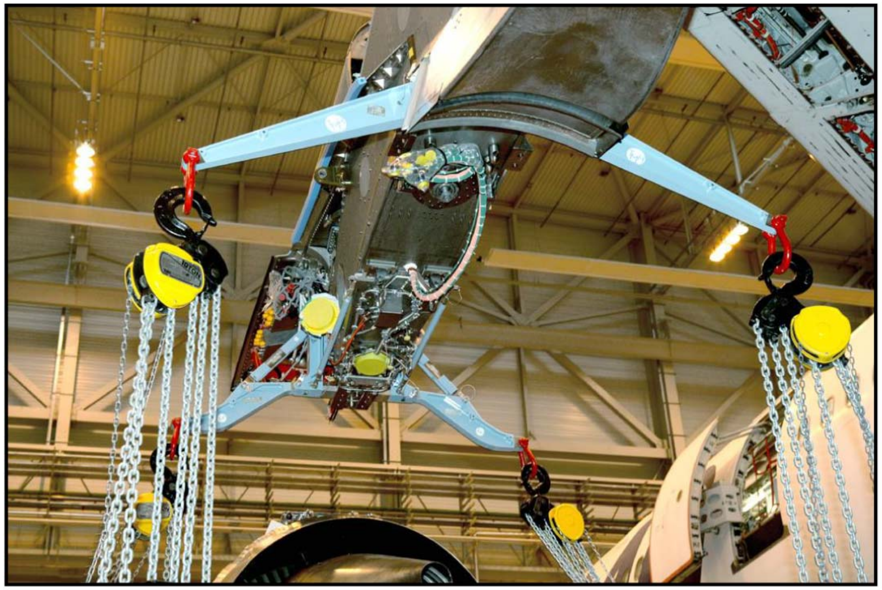
Some engine maintenance tasks require Ground Support Equipment (GSE).
Refer to the Aircraft Maintenance Manual (AMM) for the tasks.
Also, refer to the illustrated Tool and Equipment Manual (TEM) for the complete list of the tools.
Engine Removal/Installation (R/I) procedure is done using bootstraps.
Due to the weight of the pull lift (100 kg, 6 meters chain long), a specific device (mini lift) has been developed and incorporated in the bootstrap kit. This system will ease the pull lift installation by reducing the load.
Holding wrench tools for front/rear mounts have been developed to untorque the mounts in good condition.

LIFT INSTALLATION



ENGINE GROUND SUPPORT EQUIPMENT

BOOTSTRAP INSTALLATION



TORQUE WRENCH

ENGINE GROUND SUPPORT EQUIPMENT

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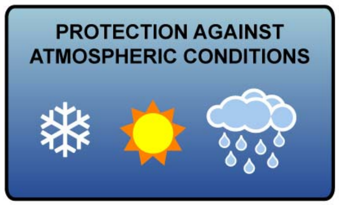
ENGINE MAINTENANCE (1)

Engine Storage And Preservation

Storage and preservation procedures must be applied for engines being not operated for a period of time according to the AMM. The preservation procedures protect the engine against corrosion, liquid and debris entering the engine, and atmospheric conditions during period of inactivity.

CAUTION: under no circumstances shall preservative oil or equivalent be sprayed into the engine inlet, core compressor or turbine, or engine exhaust. Dirt particles on wet blades and vanes may adversely affect engine performance during subsequent operation.

FOR A380, STORAGE AND PRESERVATION PROCEDURES MUST BE APPLIED FOR ENGINES BEING NOT OPERATED FOR A PERIOD OF TIME.



THE PRESERVATION PROCEDURES PROTECT THE ENGINE AGAINST CORROSION, LIQUID AND DEBRIS ENTERING THE ENGINE, AND ATMOSPHERIC CONDITIONS DURING PERIOD OF INACTIVITY.

EXAMPLE OF TRENT 900

CAUTION

UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL OR EQUIVALENT BE SPRAYED INTO THE ENGINE INLET, CORE COMPRESSOR OR TURBINE, OR ENGINE EXHAUST. DIRT PARTICLES ON WET BLADES AND VANES MAY ADVERSELY AFFECT ENGINE PERFORMANCE DURING SUBSEQUENT OPERATION.

ENGINE STORAGE AND PRESERVATION

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